PETROLEUM PROCESSING

including Petrochemical Processing Section

SEPTEMBER 1954

Barrel-Bottom Profits

Demand for asphalt grows steadily in such markets as paving and roofing
— p. 1357

Too Much Capacity?

Did the refining industry fall into over-building or has it been pushed? — p. 1360

Keep the Lines Clear

Here are techniques and tools for cleaning plant transfer lines — p. 1366

Petrochemicals Today and Tomorrow

A 52-page section covering—

- The overall status of the industry today and its potential for tomorrow
- The outlook for six groups of petrochemical products
- Your 1954 directory of petrochemical plants

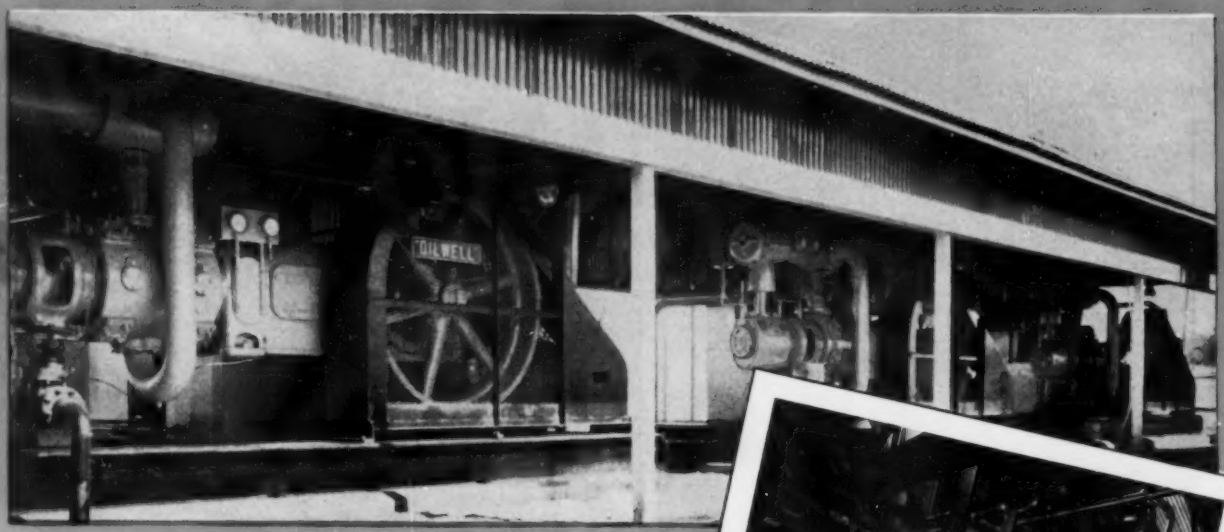
—starts on p. 1381

A McGRAW-HILL PUBLICATION

ATLAS PROCESSING COMPANY at Shreveport, Louisiana, has recently placed in operation this Hudson-Built benzene recovery plant, the first to recover substantial quantities of natural benzene from liquid hydrocarbons extracted from natural gas. Over 98% of the benzene present in motor fuel base stocks produced in gas processing plants in the Carthage gas distillate field of East Texas is extracted in this unit. The benzene is nitration grade, having a purity of over 99.6%. Hudson is proud of its part in implementing the concept of the Atlas management in this pioneering operation.

HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION • HOUSTON, TEXAS

Three "Oilwell" Compressor Units ...handle the gas from start to finish



...in this skid-mounted Portable Gasoline Plant

WHEN TURNER & WEST of Graham, Texas purchased this portable gasoline plant which is located near Loving, Texas, "Oilwell" Compressor Units were selected because of the consistently good performance and low-cost maintenance records that previously purchased "Oilwell" units had established for this customer.

Wet gas from the separator enters the compressors at atmospheric pressure and is boosted to 150-200 psi as required for processing through the plant.

A total of 275 hp is required to drive the three packaged compressors. Two GBU-75 two-stage units each have a maximum capacity of 500,000 cubic feet of gas per 24 hours of operation and one GBU-125 two-stage unit has 750,000 cfd capacity.

When you have GAS PUMPING Problems

...let an "Oilwell" representative quote on the "Oilwell" Units that meet your requirements most economically throughout the 20 to 300 hp range.

OIL WELL SUPPLY
DIVISION
UNITED STATES STEEL CORPORATION

Executive Offices—DALLAS, TEXAS
Export Office—
30 ROCKEFELLER PLAZA
NEW YORK 20, N. Y.

Area Offices— CALGARY, CANADA
CASPER, WYOMING . . . COLUMBUS, O.
DALLAS, TEXAS . . . HOUSTON, TEXAS
TULSA, OKLA. . . . LOS ANGELES, CALIF.

Branches Serving All Oil Fields

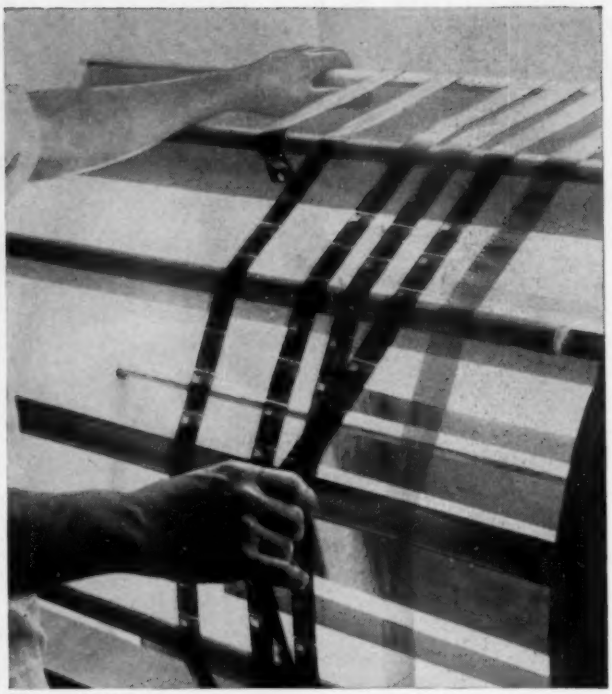
USS TRADE MARK

"OILWELL"

TRADE MARK

UNITED STATES STEEL

Paint, Varnish and Lacquer



Photographic Films

Heavy-duty Motor Oils (additives)

Success in the process! They all rely on ENJAY

for a complete line of high quality petroleum chemicals

PETROLEUM

PARANOX
PARATONE
PARAFLOW
PARAPOID
PARADYNE
PARATAC
PETROHOL
Methyl Ethyl Ketone
Dewaxing Aid
Ethyl Ether
Isopropyl Ether
Reference Fuels

SURFACE COATING

PETROHOL 91
PETROHOL 95
PETROHOL 99
JAYSOL
Secondary Butyl Alcohol
Secondary Butyl Acetate
Isopropyl Acetate
Acetone
Methyl Ethyl Ketone
Ethyl Ether
Isopropyl Ether
Dicyclopentadiene
Naphthenic Acids
Iso-Octyl Alcohol
Decyl Alcohol
Denatured Ethyl Alcohol

CHEMICAL

PETROHOL 91
PETROHOL 95
PETROHOL 99
JAYSOL
Iso-Octyl Alcohol
Decyl Alcohol
Denatured Ethyl Alcohol
Tridecyl Alcohol
Dicyclopentadiene
Isoprene
Butadiene
Ethyl Ether
Isopropyl Ether
Tetrapropylene
Tripropylene
Aromatic Tars
Benzene
Acetone
Methyl Ethyl Ketone

34 successful years of leadership in serving industry

To get proved results rely on a leader. The Enjay Company offers a wide variety of chemicals, backed up by 34 years of pioneering, research and experience. More and more industries in many different fields are depending on Enjay for successful results. Be sure you specify Enjay for *your* chemical needs.

ENJAY CO., INC. • 15 West 51st Street, New York 19, N. Y.

PETROLEUM PROCESSING

Covering petroleum and petrochemical research and the design, construction, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants, and chemicals.

September, 1954
Vol. 9, No. 9

Contents

FEATURE ARTICLES

Refining Section

Don't Sell Asphalt Short **1357**
Demand for this bottom-of-the-barrel product is growing for paving, roofing, other uses

A Small Refinery Profits from Asphalt **1359**
How Leonard Refineries, with an 18,000 b/d plant, makes a living off the local market

A Push or a Fall? **1360**
Did refiners overbuild? If so, were they pushed or did they fall into it? by Bruce K. Brown

Cleaning Plant Transfer Lines **1366**
Chemical solvents offer faster, simpler technique, by S. J. Martinez and C. W. Michaels, Jr.

Non-Profit Fractionation Research **1370**
A new cooperative program sponsored by 24 petroleum and 18 engineering firms, by D. P. Thornton, Jr.

Petrochemical Section

Petrochemicals—Today **1381**
Highlights of the current scene show output up in 1953, prices down, some overbuilding

Petrochemicals—Tomorrow **1384**
Forecast is for a slower climb in output, a boom for late-starters like acetylene, gradual change from natural gas to petroleum as raw material

The Outlook for . . .

Synthetic Rubber **1388**
By John T. Cox, Jr.

Synthetic Detergents **1392**
By Foster Dee Snell

Plastics **1395**
By Peter W. Sherwood

Sulfur **1404**
By Norman C. Updegraff

Fertilizers **1407**
By W. R. Allstetter and E. C. Kapusta

Carbon Black **1410**
By Alan F. Beede and C. A. Stokes

New 1954 Petrochemical Survey **1417**
Study shows 176 firms in petrochemicals, with 322 plants operating, building, or planned; outlay for new capacity totals $550,000,000

DEPARTMENTS

Publisher's Page	**1297**	**Plant Practices**	**1435**	**Meetings**	**1459**
What's Happening	**1299**	**Lab Practices**	**1437**	**Information Offered**	**1462**
Tomorrow	**1303**	**Patents**	**1439**	**Advertisers' Index**	**1464**
Letters	**1306**	**Personals**	**1445**	**What's New**	**1465**
Operating Trends	**1309**	**Suppliers**	**1449**	**Editorials**	**1496**
News in Views	**1364**	**Books**	**1455**		

A McGRAW-HILL PUBLICATION

Member of Associated Business Publications and Audit Bureau of Circulations

Petroleum Processing is published monthly by McGraw-Hill Publishing Co., Inc. James H. McGraw (1860-1948) founder.

Publication Office: 330 West 42nd St., New York 36, N. Y.

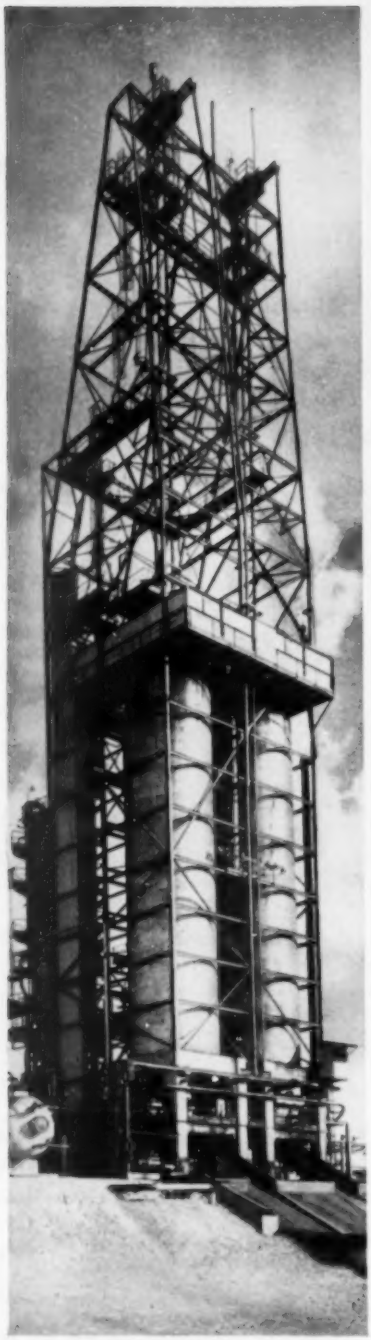
Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 West 42nd St., New York 36, N. Y. Donald C. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Executive Vice-President. Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.

Subscriptions: Address correspondence to Petroleum Processing, Subscription Service, 330 West 42nd St., New York 36, N. Y. Subscription rates: domestic single copies 35c, United States and possessions, $2 per year, $3 for two years, $4 for three years; Canada, $3 per year, $4 per two years, $5 for three years; other Western Hemisphere and Philippines, $6 per year, $12 for two years, $16 for three years; all other countries $10 per year, $16 for two years, $20 for three years.

Published prior to Sept. 1946 as the Technical Section of National Petroleum News, devoted to Refinery Management and Petroleum Chemical Technology, and including International Petroleum Technology. Entered as second class matter March 12, 1954 at the Post Office in New York, New York under the act of March 3, 1879. Printed in U.S.A. Copyright 1954 by McGraw-Hill Publishing Co., Inc. All rights reserved.

(Advertisement)

WHY DID PAN-AM BUILD TWO COKING UNITS?



Here is one of Pan-Am's Delayed Coking Units. Like many other refineries confronted with a surplus of fuel oil and an increasing demand for gasoline and diesel fuel, Pan-Am has installed these units to produce coker gasoline and gas oils for catalytic cracking from reduced crude. Coke yield is a function of the residue.

By charging reduced crude to the coke drums and drawing off gasoline and gas oils, a greater proportion of the crude is converted to gasoline and diesel fuels—and the coke finds a ready market.

WHY THE OIL INDUSTRY CHOSE SCRAPER STORAGE

Why has this most highly mechanized, efficient, and cost-conscious industry chosen Sauerman Scraper Storage equipment to solve a comparatively new problem—that of handling, storing and shipping coke? Why not other materials handling machinery?

The answers to these questions can be given in a few words: (1) lower labor cost, (2) lower maintenance cost, (3) safety.

Scraper Storage machines are operated entirely by one man. He sits in a safe, enclosed cab overlooking the entire storage area. His job requires little physical effort, consequently he retains his alertness all day, *a highly important factor in accident prevention.*

With Scraper Storage machines, motors, hoists and controls are entirely removed from the storage area—away from dust and dirt, safeguarded against weather and not subject to collisions, overturning or other damage. Only the Crescent bucket and the cables contact the abrasive material. Highly machined parts and lubrication systems are kept relatively free from coke dust, since they do not travel on the material.

A Scraper Machine maintains its efficiency for many years. When parts are replaced — sheaves, clutch or brake linings—the machine is restored to practically new condition, even though it may be twenty or more years old.

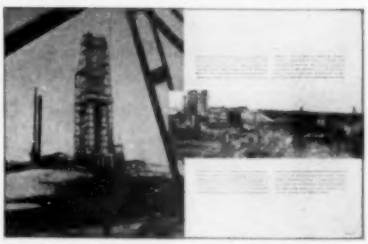
On all of these Delayed Coking Installations, full consideration was given to all types of modern materials handling machinery. *The conclusions reached favored Sauerman Scrapers as being the most economical storage machine for the job.*

For the complete details about why the oil industry chose Scraper Storage, write for the brochure described in the right-hand column.

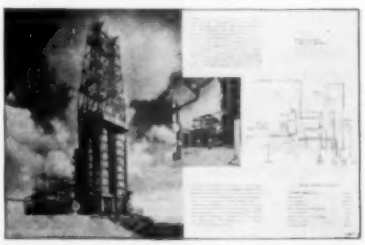
Why Did LUMMUS Recommend This Equipment for Both Pan-Am and Standard Oil Company of Indiana?

This 24-page brochure contains factual information on handling abrasive materials in large quantities that will prove very helpful to you. It's the complete story on the Pan-Am and Standard Oil Company (Indiana) coking processes. If you're an oil man, you'll want a copy.

Coke slides down the chute at Destrehan into a dewatering basin to be stockpiled, reclaimed or loaded for shipment. This installation is working proof of how to do the job fast and economically. *See pages 12 and 13 of brochure.*



The Pan-Am storage areas are large enough to house at least 30 days production, or more than 12,000 tons of coke. The operator has a clear view of the area and controls all movements of the Scraper machine from his station high up on the coke tower. *See pages 16 and 17 of brochure.*



Pan-Am's modern refinery and coking operation at El Dorado. This Delayed Coking Unit handles 9,300 barrels of charge stock per day. *See pages 8 and 9 of brochure.*

Write today for this brochure, describing the modern method of handling petroleum coke.

SAUERMAN BROS., Inc. 524 S. CLINTON STREET CHICAGO 7, ILLINOIS

PETROLEUM PROCESSING

Publisher's Page

A McGRAW-HILL PUBLICATION

Editorial & Business Offices
330 West 42nd St., New York 36, N.Y.

Harry L. Waddell, *Publisher*
Warren C. Platt, *Consulting Editor*

Editorial Staff

William F. Bland, Editor
William C. Uhl, Managing Editor
Virgil B. Guthrie, Associate Editor
Robert L. Davidson, III, Assistant Editor
William A. Caperell, Jr., Art Director
Stuart D. Boynton, Editorial Assistant
Jane L. Witzig, Editorial Assistant
D. P. Thornton, Jr., Southwestern Editor
810 First Nat'l. Bank Bldg., Houston 2
Charles Pollak, West Coast Editor
1111 Wilshire Blvd., Los Angeles 17
Andrew R. Patla, Washington Editor
1188 Nat'l. Press Bldg., Washington 4
Peter J. Gaylor, Patent Reviewer

Business Staff

K. W. McKinley, Advertising Sales Mgr.
Peter S. Carberry, Sales Promotion Mgr.
John E. Thompson, Production Mgr.

Regional Sales Representatives

NEW YORK 36, N. Y.
Fred R. Emerson, 330 West 42nd St.
Walter W. Patten, 330 West 42nd St.
PHILADELPHIA 3, PA.
C. J. Jefferis, 17th and Sansom Sts.
ATLANTA 3, GA.
S. T. Henry, 801 Rhodes-Haverty Bldg.
CLEVELAND 15, OHIO
David G. Sawyer, 1510 Hanna Bldg.
CHICAGO 11, ILL.
Robert W. Bruley, 520 N. Michigan Ave.
HOUSTON 2, TEXAS
George Reid, 810 First Nat'l Bank Bldg.
SAN FRANCISCO 4, CALIF.
Ralph Dorland, 68 Post St.
LOS ANGELES 17, CALIF.
Joseph Allen, 1111 Wilshire Blvd.

If You Don't Agree — Please Let Us Know

SO many things are happening to us these days that it's a little difficult to know just what to talk to you about this month.

There's this particular issue, for example—our Third Annual Petrochemical Outlook issue, which contains eight feature articles on Petrochemicals and our 24-page annual directory of Petrochemical plants—60 pages in all. By virtue of that "plump" Petrochemical coverage, this issue has the distinction of setting three records: 1—the largest Petrochemical section we've yet published (60 pages compared to a previous high of 28 in April '52), 2—the largest total editorial content in one issue of PETROLEUM PROCESSING (117 pages as against 94 in May of this year), 3—the largest single issue of PETROLEUM PROCESSING to date (224 pages against 202 in Oct. '53).

The Petrochemical directory itself starts on pg. 1417, and I suspect some of you might be surprised at how much work is involved in compiling such a listing, even as small as it is. To arrive at the final list of 322 plants, inquiries were sent initially to 393 plants. These included the 271 listed in our 1953 directory, plus 122 additional ones which one source or another had indicated as "prospective listees." (About half the prospects, by the way, turned out to be duds—wrong names, duplications, abandoned projects, or simply not petrochemical operations.)

That was only the beginning. To straighten out discrepancies, fill in missing information, and get data on those firms which didn't respond to the "first call," we had to make over 220 follow-ups. Most of them were either telegrams or telephone calls—157 of the latter alone. Field editors in four major areas throughout the country were called on to dig up first-hand data, particularly in cases where we couldn't ferret it out from New York.

The result—a directory of Petrochemical plants in the U. S. and Canada which we believe is the most accurate and complete such listing available. If you have reason to dispute that statement, I'd greatly appreciate hearing from you so that we can take steps to correct any unintentional omission.

William F. Bland
Editor

P. S.—The other things happening to us include the fact that PETROLEUM PROCESSING is now an "ABC" magazine (see pp. 1340-41) and some staff changes—about which we'll have something to say next month.

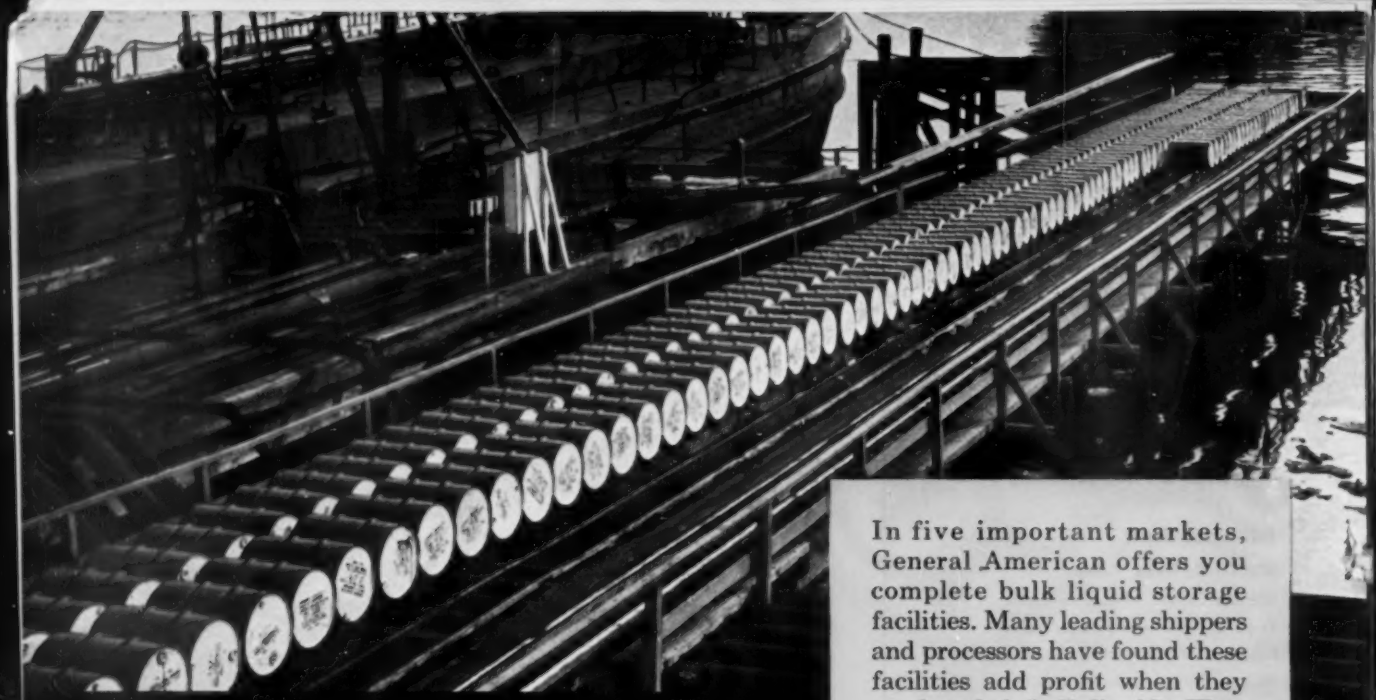
—W. F. B.

Other McGraw-Hill Petroleum Publications

National Petroleum News
The weekly oil marketing magazine, covering news, prices, transportation, storage, merchandising.

Platt's Oilgram News Service
A daily independent oil-news reporting service issued from New York, Chicago and Houston.

Platt's Oilgram Price Service
A daily independent oil-price reporting service issued from New York, Chicago and Houston.



Store and Distribute

your bulk liquids as the market demands— with no capital investment

GENERAL AMERICAN TANK STORAGE TERMINALS

a division of GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street · Chicago 90, Illinois

In five important markets, General American offers you complete bulk liquid storage facilities. Many leading shippers and processors have found these facilities add profit when they market their bulk liquids. They can maintain inventories of their products for distribution at the right time and place; gain economies of shipping in bulk; and *conserve* capital.

Modern storage tanks . . . for anything that flows through a pipeline . . . are yours to use. You can be sure of privacy. Carefully guarded manifolds, pipes and pumps to protect your product against contamination. Barrelling, drumming, canning and blending services at New York, New Orleans and Chicago. All this, without capital investment on your part!

Ask about the marketing advantages you receive from leasing General American's tank storage terminal facilities.

General American's terminals in these five important markets:

Port of New York (Carteret, N. J.)

Port of New Orleans (Goodhope, La.)

Chicago, Illinois

Port of Houston (Galena Park and Pasadena, Texas)

Corpus Christi, Texas

What's Happening...

in Refining

. . . **Total U.S. refining capacity rose** from 7,638,661 to 8,006,896 b/d in 1953, an increase of more than 368,000 b/d, according to latest report by Bureau of Mines, although number of operating refineries dropped from 343 to 337.

Additional capacity totalling 397,500 b/d was reported under construction at beginning of 1954, with 129,500 b/d of this in new refineries (three in No. Dakota, two in Washington, and one each in Ohio and Utah). Balance represented expansions in existing facilities.

. . . **Socony-Vacuum Oil Co.'s** plans for expansion now include nine more new catalytic reforming units in addition to four now under construction. The 13 units are part of a $165,000,000 program for the years 1954-55-56 and will total about 130,000 b/d.

Scheduled for immediate construction are new units at East Chicago, Ind., Paulsboro, N.J., and Trenton, Mich. These will be followed by units at Buffalo and Brooklyn, N.Y., East St. Louis, Ill., and Casper, Wyo. Others will be built at General Petroleum, Torrance, Calif., and Magnolia Petroleum, Beaumont, Texas. All are "Sovaformers," a fixed bed process using a platinum type catalyst. The earlier units in the program include TCR units, moving-bed type using a chrome-alumina bead catalyst.

. . . **Avtane Refining Co.,** new southwestern firm, has awarded Tears Engineers process design contract for new 10,000 b/d refinery, to be built at Freeport, Texas. Negotiations are under way for a site and for construction contract. Building is expected to start before year's end and completion is called for mid-July, 1955.

Plans include: 10,000 b/d crude topping, 5,000 b/d vacuum distillation, 2,000 b/d cat reforming, 4,000 b/d catalytic cracking, plus isomerization, dehydrogenation, and alkylation. Type of reforming and cracking units has not been decided.

. . . **New construction projects,** as indicated by recent fast tax write-off approvals granted by the Office of Defense Mobilization, were:

Standard Oil Co. (California), $300,000 for additions and modifications to crude still at El Segundo, Calif.

Humble Oil & Refining Co., $473,000 for facilities for increasing alkylation capacity at Baytown, Texas.

Gulf Refining Co., $4,600,000 for a 10,000 b/d catalytic reformer and auxiliary facilities at Cleves, Ohio. Reformer is estimated at $2,900,000.

Utah Oil Refining Co., $212,130 for a 750 b/d catalytic polymerization unit at Salt Lake City.

Sinclair Refining Co., $12,800,000 for proposed new 16,000 b/d catalytic reformer and related facilities at East Chicago, Ind. Estimated cost for the reformer is $8,200,000, for auxiliaries and buildings, $4,600,000.

The Texas Co., $6,900,000 for a 9040 b/d catalytic reformer and other facilities at West Tulsa, Okla.

. . . **Imperial Oil Co. Ltd.,** will take bids October 25 for a refinery near Dartmouth, Nova Scotia, to cost between $25 and $30 million.

. . . **Pan-Am Southern Corp.,** El Dorado, Ark., has put onstream first commercial Ultraformer (fixed-bed catalytic reforming, Indiana Standard process) of 7300 b/d capacity, 147 days after construction began. Lummus Co., was the builder.

. . . **Shell Oil Co.,** Martinez, Calif., has put onstream 5000 b/d UOP Platforming unit.

. . . **Tide Water Associated Oil Co.,** Avon, Calif., has put onstream expanded refining facilities, including feed preparation, thermal cracking, etc. Fluor Corp. was contractor.

. . . **Rock Island Refining Corp.,** Indianapolis, Ind., has put onstream its new UOP Platforming unit, said to be first reformer controlled entirely by electronic instrumentation. Unit has feed capacity of 2400 b/d.

. . . **Standard Oil Co (Indiana)** will dedicate its new 30,000 b/d refinery at Mandan, N.D., in the Williston Basin crude oil supply area, October 2. Start-up operations are expected to have taken place by that time, though company reports it is not yet certain.

in Petrochemicals

. . . **Standard Oil Co. (Ohio)** will invest $17,000,000 in a nitrogen chemicals plant in the Toledo-Lima, Ohio, area. Construction is expected to start this month and completion is scheduled for about a year hence. Plant will produce 300 ton/day of anhydrous ammonia, of which almost 200 tons will be processed into about 125 ton/day of urea, 60 ton of nitric acid, and over 200 ton of nitrogen solutions. Raw material will be by-product hydrogen from Lima Platformer, supplemented by natural gas. M. W. Kellogg Co. will build the ammonia plant, several sites for which are still being considered.

. . . **Brea Chemicals Inc.** has started construction of a new ammonium phosphate plant at Brea, Calif. It is the first of three, scheduled for completion by early 1955 at a total cost of $500,000. The others are at Fresno and Brawley, Calif.

. . . **Salt Lake Chemical Co.,** of Dallas, Texas, plans immediate construction of an $8,000,000 anhydrous

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

ammonia plant at Salt Lake City, Utah, with capacity of 120 ton/day of ammonia and 30 ton/day of dry ice when operations begin by December, '55.

. . . **Chillicothe Petrochemicals, Inc.,** recently organized, is planning a $12 to $14 million plant at Chillicothe, Texas, to produce 180-200 tons/day of ammonia and 150 tons/day of urea, from natural gas. Processes and contractors are yet to be selected. Financing has not been completed.

. . . **du Pont** has acquired options on land in California looking forward to possibility of construction of a plant for manufacture of tetraethyl lead and "Freon" refrigerants. Design work is underway.

. . . **Allied Chemical & Dye Corp.** (Nitrogen Division) plans to double the ammonia capacity at its new Omaha, Neb., plant. Construction will start as soon as the necessary supply of natural gas as raw material has been assured. Plant, recently completed, has capacity of 61,000 ton/yr of nitrogen in form of ammonia and urea.

. . . **British Dominion Oil Co.,** a new firm, reports progress on final negotiations for constuction of an $18,000,000 ammonium nitrate fertilizer plant in southern Alberta, exact location undecided as yet.

. . . **Cooperative Farm Chemicals Association** has dedicated its $15,000,000, 330 ton/day, ammonia and nitrogen chemicals plant at Lawrence, Kans. Girdler Co. was designer and constructor.

in Markets and Prices

. . . **The market picture brightened** considerably in August after a gloomy July. The impending crisis of a general cut in crude oil prices appears to have been averted when refiners applied the brakes to crude throughput. Refined products prices started upward almost immediately in one of the sharpest turn-arounds in recent years.

. . . First sign that the impending crisis had passed came late in July, when prices for most grades of gasoline, the refined market barometer, went up 0.25¢ on the Gulf Coast, Heavy buying followed and two more hikes of 0.25¢ each sent regular-grade gasoline up to 10.5¢ for cargo lots.

. . . Distillate oils were next to go up at the Gulf, with No. 2 fuel oil in cargo lots up 0.5¢ to 8.25¢ per gal. And on shipments from Group 3, No. 6 fuel oil went up 10¢, to $1.10/bbl., with some Midwestern refiners turning away bids at higher prices.

With the spread between Gulf and East Coast prices at nearly all-time lows, prices along the Atlantic Seaboard were quick to rally. Atlantic Refining Co. advanced its tank wagon prices for gasoline 0.4 to 0.6¢ generally throughout Pennsylvania, and Standard of Ohio boosted its gasoline prices 0.6¢/ gal.

. . . **Heating oil prices** in seaboard terminal markets also firmed up, with general withdrawal of discounts and allowances which suppliers had been granting from posted prices.

in Foreign Operations

. . . **Shipments of crude oil and products from Iran** will resume in a few months, with completion of an agreement to restore Iranian oil industry. Total will reach 500,000,000 bbl. during first three years after resumption of operations.

Agreement must still be ratified by Iran's parliament, and that is expected by October 1. Refinery is said to be in condition such that high level of operation can be reached soon after start-up.

. . . **Orobis Ltd.,** a new British corporation, has been formed by Oronite Chemical Co. and Distillers Co. Ltd. It is constructing a plant at Hull, England, to manufacture lube oil additives. Products as made by Oronite in the U.S. will be manufactured and marketed by Orobis. Plants will be in operation by the end of this year.

. . . **Iraq Oil Refineries Administration** will soon ask for bids on construction of lube oil plant, to have capacity of about 480 b/d and cost $8,400,000.

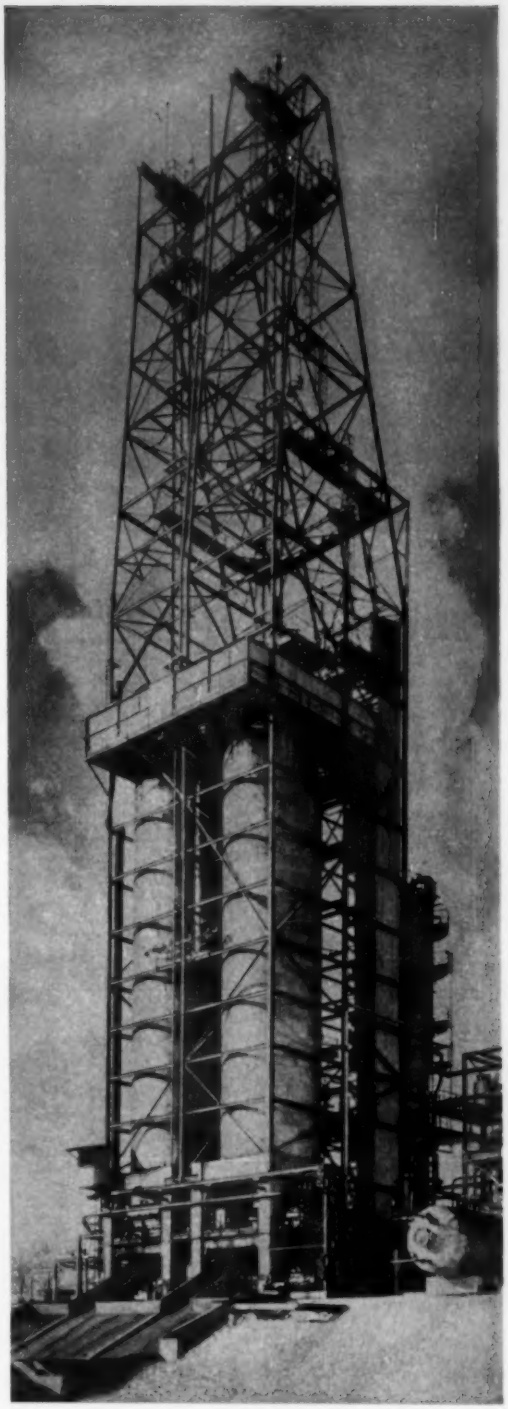
in Transition

. . . **Globe Oil & Refining Co.** has sold all its refining facilities at Lemont, Ill., to Pure Oil Co. Acquisition of 47,000 b/d plant brings Pure's total refining capacity to 170,000 b/d. None of Globe's marketing facilities were involved in the transaction, and arrangements have been made for Pure to process crude oil for Globe.

. . . **Universal Oil Products Co.** has lost one of oil industry's most bizarre lawsuits, dating back to 1931, with granting of judgment by Judge R. S. Rodney of U.S. District Court in Wilmington, Del., in favor of William Whitman Co., Inc. (dissolved in 1946) for $245,168.55 in a patent licensing case. Suit had its foundation in litigation over alleged infringement of cracking process patents in the mad scramble for leadership in early days of petroleum cracking technology.

. . . **Union merger seemed certain** between Oil Workers International Union and United Gas, Coke, and Chemical Workers (both CIO), at mid-August when rank-and-file committees completed work on details. Final approval must still come from each union at its annual convention, UGCCW in September and OWIU at a later date.

LUMMUS COKING UNITS
give top performance for
Pan-Am Southern



Lummus has built two delayed coking units for Pan-Am Southern Corporation in the past few years, one at El Dorado, Arkansas, and the other at Destrehan, Lousiana... and Pan-Am Southern is well satisfied with them.

The El Dorado unit, despite a 42 day steel strike during the construction period, was completed ahead of the specified date, and for less than the guaranteed maximum cost. It was designed to charge 9,300 B/D of reduced crudes, but since coming on-stream, the daily rate has averaged 10% above the designed capacity. The unit went on-stream immediately and operated 181 out of the first 199 days after completion (a 91% service factor). In the first half of 1953, it achieved and has since averaged a 97% service factor (224 day run, 6 day down-time). On-stream maintenance and repair costs are correspondingly low.

Gas oil from the coker (53% yield of reduced crude charge) is used for catalytic cracking charge stock where its low Conradson carbon allows it to be processed without penalty. Yield structure compares favorably with that obtained from catalytic cracking of virgin gas oil. The coke produced in the process is of sufficiently high quality for use in the manufacture of electrodes for aluminum production.

The new (and similar) Destrehan installation is achieving equally satisfactory records.

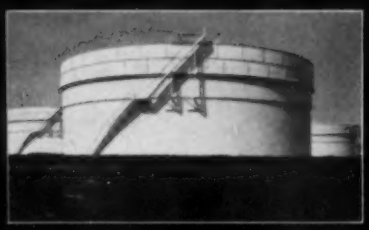
Lummus engineers have done an outstanding job for Pan-Am Southern. Why not consult with Lummus on *your* next coking project?

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Indiana.

LUMMUS

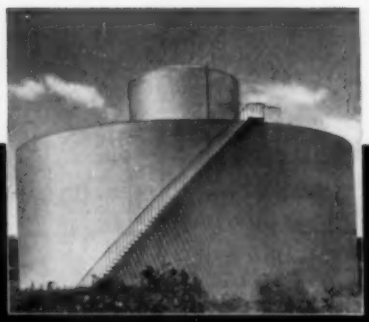
DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

GRAVERSPHERES are used to store natural gasolines and volatile liquids including butane, butadiene, etc. They are ideal for storing gases—sustaining pressures up to 100 psi. and greater. Capacities range from 500 to 20,000 bbl.



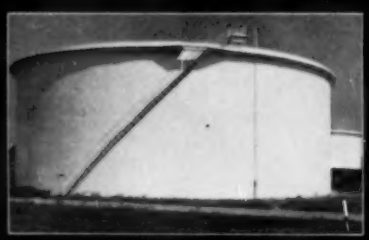
GRAVER EXPANSION ROOF TANK eliminates breathing losses and minimizes filling losses. Its positive liquid seal, exclusive with Graver, protects under all conditions. Ideal for converting existing tankage, and simple to maintain, the Expansion Roof Tank may well protect an entire terminal.

there is a GRAVER *CONSERVATION DESIGN to fit every need!*



Graver manufactures a number of conservation designs allowing you to specify what suits your exact needs. Thus your tankage can be "tailor-made" to obtain optimum efficiency and maximum economy in operation. For authoritative assistance with your conservation problems, consult your nearest Graver Sales Engineer.

GRAVER VAPOR-MIZER is an economical design that conserves vapors, using less steel in building and requiring smaller vapor lines in manifolded tankage.
The VAPOR-MIZER helps maintain the fresh quality of your product! As it operates at very low pressures, the reinforcement of manifolded tanks becomes unnecessary.



GRAVER DOUBLE-DECK AND CENTER-WEIGHTED FLOATING ROOF TANKS are two separate designs in which the roof floats directly on the liquid, preventing the formation of vapors. They are applicable to crude and product storage areas at refineries, terminals and large bulk installations.

GRAVER

tank fabricators for 97 years

GRAVER TANK & MFG. CO., INC.

East Chicago, Indiana

NEW YORK • CHICAGO • PHILADELPHIA • ATLANTA • DETROIT • CLEVELAND
PITTSBURGH • HOUSTON • CATASAUQUA, PA. • SAND SPRINGS, OKLA.
CASPER, WYO. • ODESSA, TEXAS • LOS ANGELES • EDGE MOOR, DEL.
TULSA • SAN FRANCISCO • FONTANA, CALIF.

Providing Turbulence in Columns May Be Key to Better Extraction

REFINERS have used liquid-liquid extraction for decades in treating light products, dewaxing, and —more recently—solvent refining of lube oils. The density between the two phases has provided the only means for separation.

Promise is seen in research work reported recently[1] of increasing the efficiency of conventional extraction equipment by introducing turbulence into the column by an outside source.

Specifically, this means providing a pulsing action that—in a plate column—forces liquids through the holes alternately in opposite directions. In a packed column, the pulsing increases agitation.

The work on pulsation in packed columns has been done at Cornell University, while an extensive series of studies on pulsed sieve-plate columns has been supported by the Atomic Energy Commission. The extent of use of pulsed columns in atomic energy plants is still classified information. Some of the larger chemical companies have also shown interest in the subject, but no large scale use of pulsed columns has yet been reported.

A simplified picture of what takes place in a pulsated sieve-plate column follows:

"Imagine the column with a layer of heavy liquid resting on each plate and a layer of light liquid collected under each plate. On the up stroke of the pulsator, the displaced column of light liquid is forced through the holes in jet streams into the heavy liquid above. On the down stroke, the reverse takes place, with the heavy liquid jetting downward through the light liquid."

Ideal operation, i. e., maintenance of two distinct layers of liquids between plates, will not often be met in practice, it is pointed out. However, if the pulsator is operated with a frequency low enough to allow coalescence after each stroke, ideal conditions will be approached, and an efficient method of operation achieved.

Mechanism of pulsation in a packed column is pictured as follows:

"At low degrees of turbulence, the dispersed phase is well mixed and distributed so that we get good contact between phases and little channeling. As we increase the intensity of agitation, the droplets break up more often and into smaller droplets. These, in turn, coalesce with other droplets they hit and then break up again. This action results in excellent mass transfer, reaching a maximum at a specific degree of turbulence."

Summing up the performance of pulsed columns, it is stated: "We see, therefore, that pulsation allows efficient operation of an extraction column in a region of feed rates where, ordinarily, extraction efficiency is poor. We can get flexibility in operation by adjusting the pulsator to an optimum operating condition irrespective of feed rates or ratios."

The pulsator giving the impulse may take a number of different forms: "Although it may be as simple as an automobile fuel pump, a piston or bellows pump with adjustable stroke is more commonly used. A standard reciprocating steam pump is effective, particularly for larger columns. In all cases, the valve arrangements must be modified, usually by removing the check valve from one port and by sealing the other port."

One practical advantage seen for the pulsation technique on extraction towers: it would require comparatively simple modification of existing refinery equipment, as far as packed columns are concerned. Such a column has several available openings to which pipe connections may be made. The design of a pulsed sieve-plate column might be more involved, and the liquids used in sieve-plate operation must be very clean to avoid plugging. —V.B.G.

(1) "Key to Better Extraction," H. F. Wiegandt and R. L. Von Berg, Cornell University; *Chemical Engrg.*, July, 1954, pp.183-8.

Promise in Carbon Black Process Backed up by Plan for New Plant

ONE recently developed process for making carbon black, the so-called "Lynn Furmatic" method, will soon become a commercial reality.

A new company, Consolidated Carbon Corp. of Illinois, has completed preliminary plans for the first of ten new plants to be built in Texas in the near future. The exact location of the $500,000 plant has not yet been determined.

Designed to process 2,500,000 CFD of natural gas, the new plant is expected to be completed later this year. Consolidated Carbon says the Lynn Furmatic process is cheaper and will produce a higher yield than any process now being used.

Average yields have been estimated at 12 lb. of carbon black per 1000 cu. ft. of gas, compared with about 7.4 lb. for the furnace process and 1.9 lb. for the channel process. These yields have been made on pilot plant operations, but Consolidated believes full-scale operation will be even better.

Based on these figures, the new plant can be expected to produce about 30,000 lb., or 15 tons per day of carbon black. This figures to an investment cost of about $33,000/ton/day.

By comparison, a channel black plant in Texas now producing 7,200,000 lb/yr (10 ton/day) cost $460,000, or $46,000/ton/day to build; and a furnace black plant producing 40,000,000 lb/yr (57 ton/day) cost $2,750,000, or around $48,300/ton/day.

In addition to the lower capital investment, the process is fully automatic and operating costs are estimated at 60% of those for the conventional furnace type process.

Feature of the process apparently is use of close automatic control of variables such as feed, air, temperature, etc. Officials of Lynn Carbon Black, the patent holder, say it incorporates some of the best features of all three current processes—channel, furnace and Thermatomic, without infringing on any.

Listed as key engineering features are: specially-designed burners, a zoned furnace, and two-stage air-cooling of product gases. Water injection for cooling has been eliminated because it gives a poor quality carbon black.

Process will operate entirely on natural gas, or a mixture containing as much as 50% oil. Product is a mixture composed of channel, furnace, and a catalytically cracked type of black.

Even with the royalty arrangement Consolidated has made with Lynn Carbon Black, of at least one cent/lb (on a graduated scale), this kind of an operation appears economically interesting, and it certainly can expect careful watching by the carbon black industry. —W.C.U.

Peat Wax Is Seen by British as Possible New Source of Chemicals

EVEN the experts will admit it's a bit into the future and still a crystal-ball proposition, but many of them are going to be interested in the work being done by the British at their Fuel Research Station on peat, an abundant fuel in the British Isles.

The material, in the form of peat wax, is suggested as having interesting possibilities in chemicals manufacture, particularly in the organics field.

Peat wax consists of a series of high molecular weight organic compounds, containing three or more functional groups such as carboxylic acid, ester, and hydroxyl, according to G. C. Ackroyd of the FRS in a paper at the recent International Peat Symposium in Dublin.

Plastics production with valuable properties should be possible with molecules of this type, he pointed out.

The wax is a complex mixture. On the basis of differing solubilities in organic solvents, an arbitrary division can be made of the crude wax into resins, true wax, and asphalt. The resins are soft, sticky materials with an average molecular weight of about 690, a high acid value, and high oxygen content. The true wax has an average molecular weight of 1330 and it contains less oxygen than the resins. The asphalt has a molecular weight averaging approximately 2090, a high ester value and high oxygen content.

The resins consist mainly of material with about 38 carbon atoms per molecule. More than 63% of this material contains an average of about 3.3 atoms of oxygen per molecule, mainly in ester groups, but with some free hydroxyl groups.

Much of the true wax consists of molecules with about 60 carbon and four oxygen atoms. An average of 2.7 oxygen atoms can be accounted for in the form of ester or alcohol. The remaining oxygen is believed to be present in carbonyl or ether groups.

About 30% of the asphalt was composed of molecules with 66 carbon atoms and averaging 7.7 oxygen atoms. Each molecule contains two ester groups, one hydroxyl group, and some carboxylic acid. About 27% of the asphalt consists of molecules with 44 carbon atoms and 6.3 oxygen atoms.

While peat is a relatively unimportant fuel in the United States, it enjoys a somewhat different reputation across the Atlantic. At this stage, it is also a long way from any commercial or economic development. However, long-range planners will be interested for some years to come. —W.C.U.

Intensive Research Will Continue For "Ideal" Gasoline Additive

IT is within the experience of this writer that when a refiner or a wholesale petroleum marketer wanted to find out whether he should include some particular additive in his motor gasoline, he would have some of his friends and good customers try it out in their own cars. If the verdict was that it was an improvement, the subject was considered properly investigated.

By comparison, the complexities involving the testing of gasoline additives today have been emphasized in a recent report by Ethyl Corp.'s technical staff.[1] Their investigation was not confined to any group or type of additive, or specific characteristic of engine performance, but rather to the broad gauging of whether or not an additive is "successful."

To improve the fuel basically, they reported, the additive should improve the durability of the vehicle. This means lengthen its efficient life. Without this broad yardstick, the particular benefits of an additive may be more than offset by detrimental effects on some other phase of engine operation.

Ten points were listed where durability of a vehicle may be affected by a gasoline additive:

Fuel system — the additive should neither corrode metal parts nor deteriorate the pump diaphragm.

Inductibility — the additive should leave no deposits in the carburetor, hot spot, manifold, intake ports, or under the heads of intake valves.

Combustion chamber deposits — the combustion products of the additive should not increase the octane number requirement due to deposits nor should they increase the tendency of normal deposits to ignite the charge.

Spark plug deposits — these should have a minimum tendency to short out the plug and should not increase the normal rate of spark plug gap growth.

Wear — the additive should not increase engine wear.

Cleanliness — general internal cleanliness of the engine should not be impaired.

Bearing corrosion — there should be no increase in bearing corrosion.

Valve life — intake and exhaust valve life should not be shortened.

Exhaust system — corrosion should not be increased.

Bumper corrosion — this should not be increased on the rear bumper adjacent to the exhaust pipe.

Recognizing the involved and intricate nature of additive testing today, refiners with even better than average research facilities are realizing some of the limitations in carrying out evaluations of a motor gasoline improver. —V.B.G.

(1) "Fuel Additives and Engine Durability," A. L. Felt, R. V. Kerley, and H. C. Summer, Ethyl Corp., presented at National West Coast Meeting, Society of Automotive Engineers, Los Angeles, Aug. 16-18, 1954.

NICHOLSON TRAPS

Can Help You Solve Any Drainage Problem

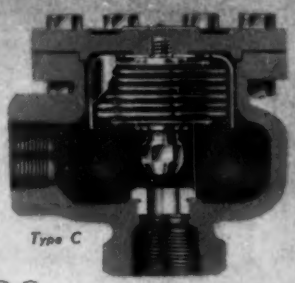
32-Page Reference Describes Advanced-Type Trapping Methods for Process Industries

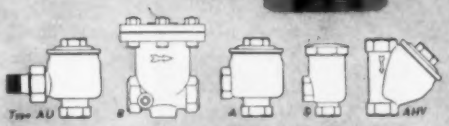
Nicholson furnishes a type and model of trap for every industrial process, power and heat application. For complete details you are invited to send for the helpful 32-page reference pictured above.

NICHOLSON THERMOSTATIC BELLOWS STEAM TRAPS

Nicholson thermostatic bellows steam traps (at right), distinguished for their fast positive action, are suited for critical processing applications. They are widely specified for continuous production and where advanced-type quality controls are in use, due to the high even temperatures Nicholson units effect and their minimum maintenance time and costs. Other advantages: above-average drainage capacity; will not freeze in operation. Specify the trap in the proper size to fit piping requirements: in 0 to 200 lb. range use type A, D, AU or AHV; to 250 lbs., use type B or C in semi-steel construction; to 300 lbs., use type C in cast steel construction. Bellows of bronze, monel or stainless.

A type for every Process, Heat and Power need. For pressures from 0 to 300 lbs.

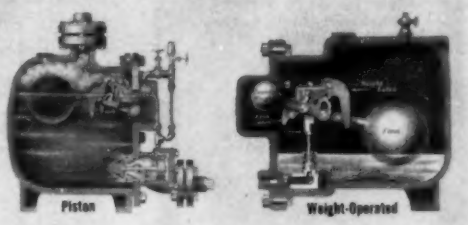




PISTON OR WEIGHT-OPERATED TRAPS

Nicholson piston-operated steam traps (right) have large capacity and are recommended wherever water is in volume; e.g., steam purifiers. Pressures: 2 to 650 lbs. Capacities: 12,500 to 552,000 lbs. Sizes: 1¼" to 2½".

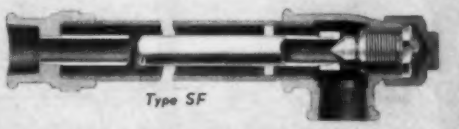
Nicholson weight-operated traps are heavy-duty types for draining steam, air and gasoline from separators, process vessels, dry kilns, accumulators, intercoolers, etc. Pressures: 23 ranges, 0 to 1500 lbs. Capacities: 1295 to 11,700 lbs. Sizes: ½" to 2"



THERMOSTATIC METAL EXPANSION STEAM TRAPS

Nicholson expansion steam traps (right) require extremely low maintenance. Because they are readily adjusted to pass condensate at any point below 212°F, processing and refining plants have adopted these traps as low-cost temperature regulators on storage tanks which must be maintained at certain temperatures. Freeze-proof. Pressures: 0 to 250 lbs. Sizes: eight, ¼" to 2".

RADIATOR TRAPS -- Thermostatic bellows type for vapor and vacuum heating systems under 25 psi.



NICHOLSON WELDED FLOATS

Standard with hundreds of manufacturers. Light and heavy-duty types. For mechanisms or as vessels; 2" to 14" diam. In stainless, monel or plated steel.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

215 OREGON ST., WILKES-BARRE, PA.

Sales and Engineering Offices in 58 Principal Cities

 (To obtain more data on advertised products see page 1464)

"Tube Troubles?

. . . we licked those long ago . . . with AIRETOOL tube cleaners and tube expanders"

Airetool Series 6000 motors have ball-bearing thrusts front and rear . . . reducing friction to give more power. "Slip-fit" construction . . . no tools needed. Single expansion-type cutter head rapidly and thoroughly cleans coke from straight tubes.

When production lags, profits quickly go down! Keep your production at high levels by eliminating expensive shutdowns due to tube failure . . . simply and easily . . . by using Airetool Tube Cleaners and Expanders regularly, to keep your tubular equipment at peak efficiency. Powerful Airetool motors permit the use of any combination of cutter, drill or brush cleaner heads; safely, completely removing all types of scale, coke, or other foreign deposits from straight and curved tubes of any diameter or radius. If your tube problems are causing your production worries, our tube maintenance experts can help you! Write to us today.

There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

Tube ends in condensers and heat exchangers are automatically rolled to consistently accurate, tight joints with the Airetool Automatic Tube Expansion System. Precise control eliminates over-expanding of tubes and distortion of tube sheets; provides maximum bonding to insure trouble-free tube joints.

AIRETOOL MANUFACTURING COMPANY

SPRINGFIELD, OHIO

REPRESENTATIVES:
Representatives in principal cities of U.S.A., Canada, Mexico, South America, England.

BRANCH OFFICES:
New York, Philadelphia, Chicago, Tulsa, Houston, Baton Rouge

Letters

Chemofining

To THE EDITOR: . . . I read the article on Chemofining [July, 1954, pp. 1070-4] with considerable interest. This is a very novel approach which has been discussed by many of us on previous occasions, but in no instance have we taken the time to work it out as have Eppard and Wingard.

It should give some people food for thought. Undoubtedly, many of us could take issue with their balance sheet. Nevertheless, it is a most interesting approach.

W. E. KUHN
Manager, Tech. & Res. Div.
The Texas Co.
New York 17, N.Y.

To THE EDITOR: . . . The novel approach I think is good. However, I believe it will have to grow on one a bit. Of course, with twenty-five days of 90° weather, nothing stands out in proper brilliance.

GUSTAV EGLOFF
Universal Oil Products Co.
Des Plaines, Ill.

To THE EDITOR: This smacks just a little too much of "day-dreaming" to suit my tastes. I would prefer a less fanciful approach to predicting future possibilities. Furthermore, it appears to me that the authors have merely rearranged some standard well-known processes, rather than "inventing" some new and possibly more economical methods. Undoubtedly plants of the future will use processes we are not familiar with today.

NORMAN C. UPDEGRAFF
The Girdler Corp.
Louisville, Ky.

To THE EDITOR: . . . the article . . . is excellent and it is something that has needed doing. However, it should be read with several factors clearly in mind. Their "project" is an example of pyramiding one profit on another and it is only in this way that the results can be at all attractive.

Of course, manufacturing operations are regularly carried out in this way, and there is nothing economically wrong with the idea of improving the profit picture by making end-products instead of intermediates. But, it is always difficult to use a composite picture of process economics for purposes of comparison with other ways of doing the same thing.

I suspect that long after petroleum has ceased to be a prolific fuel, chemicals will still be produced from by-

products that will continue to be the cheapest sources.

EUGENE AYRES

Pittsburgh, Penna.

Statistical Error

TO THE EDITOR: . . . I would like to call your attention to three typographical errors in ("Statistics for Everyday Use" April, 1954). On page 526, near the middle of the third column, the formula:

$$S = \sqrt{\Sigma (X - X)^2/(N - 1)}$$

should have had a horizontal bar over either X, thusly: $\overline{X}$. On the next page, the last line in the first column on the left was apparently transposed from its correct position at the bottom of the middle column.

On that same page, 527, near the bottom of the right-hand column a line of type is missing. The last sentence in the definition of the term "studentized" should have read: "Here it means specifically the difference of one extreme of data from the average, divided by the standard deviation, to measure the divergence from the mean in units of the standard deviation."

C. T. SHEWELL
Research Specialist
Humble Oil & Refining Co.
Baytown, Texas

• *Thank you, reader and author Shewell. The corrections will be made in the reprints of your very valuable series of articles on statistics.*

Water Treating

TO THE EDITOR: We wish to offer the following comments on one section of the excellent article by George E. Shaffer, Jr., of Milton Roy Co., in the June 1954 issue of PETROLEUM PROCESSING ["Some Solutions to Flow Control in Water Treating," pp. 891-893]. We refer to the section on "Oxygen Scavenging Boiler Feed" on pg. 893.

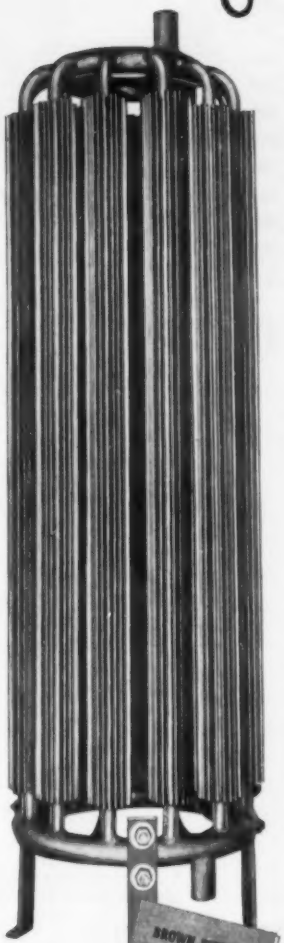
In referring to the use of hydrazine as a deoxygenating agent in boiler feedwater, Mr. Shaffer mentions—"High chemical cost (several dollars per pound) . . ." This statement can be misleading because a usual central power station purchase is one or more 240-lb. drums of 54.4% hydrazine solution. [In this quantity] . . . the price is $1.55 per pound of solution, which is approximately equivalent to $2.86 per pound of N_2H_4.

A further statement is that this high chemical cost makes over-treatment prohibitive.

Actually, over-treatment is not only unnecessary with hydrazine, but also undesirable. In starting to use hydra-

4 reasons why

BROWN FINTUBE TF-18 TANK HEATERS HAVE OBSOLETED OLD FASHIONED TANK COILS



1) **LOWER COST**—Users report that the cost of TF Heaters plus their installation is usually less than the cost of just installing bare pipe coils of equivalent capacity.

2) **VERTICAL MOUNTING**—on legs about 10" above the tank floor brings the entire heating surface in contact with the tank contents—avoids heating through a layer of sediment.

3) **MUCH INCREASED EFFICIENCY**—Finned construction provides approximately 7 times more heating surface per foot of tube length than plain bare pipe—permits more heat to be transferred—faster—at lower temperatures per square foot of surface, avoiding coking or damage to heat sensitive products.

4) **EASY INSTALLATION**—TF-18 heaters pass easily through a standard manhole permitting installation in new or existing tanks. They do not require welding inside the tank. Manifolded into groups or individually trapped.

You can't keep your operations competitive with old fashioned, obsolete methods. Write today. Get full details about these new, fully proved, less costly, more efficient tank heaters.

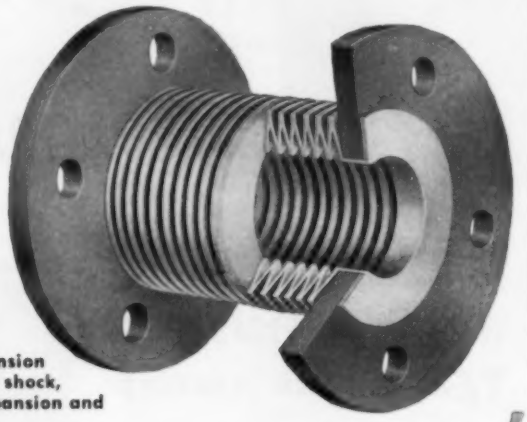
New fully descriptive Bulletin No. 541 gives dimensions and full details. Write for your copy today.

BROWN FINTUBE
HEAT TRANSFER PRODUCTS

Brown Fintube Co. Elyria, Ohio

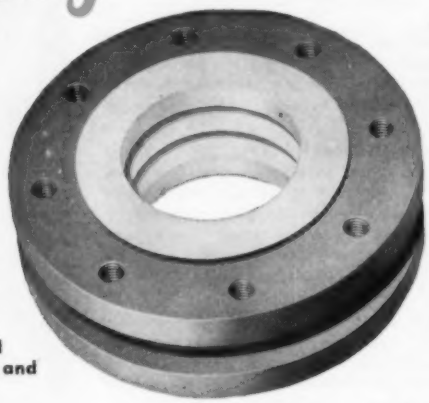
NEW YORK • BOSTON • PHILADELPHIA • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI • DETROIT
CHICAGO • ST. PAUL • ST. LOUIS • KANSAS CITY • MEMPHIS • BIRMINGHAM • NEW ORLEANS
SHREVEPORT • TULSA • HOUSTON • DALLAS • DENVER • LOS ANGELES • SAN FRANCISCO
BROWN FINTUBE (CANADA) LTD., ST. THOMAS, ONTARIO, CANADA
BROWN FINTUBE (GREAT BRITAIN) LTD., BIRMINGHAM, ENGLAND
FRIEDRICH UHDE, GMBH, DORTMUND, GERMANY

good insurance...



Chemiseal TEFLON Expansion Joint absorbs shock, vibration, expansion and contraction.

...against costly Chemical Piping Casualties



Chemiseal TEFLON Flexible Coupling corrects misalignment and absorbs shock and vibration.

Chemically Impervious ...Non-Contaminating

Write for Bulletin FC-952.

UNITED STATES GASKET COMPANY

CAMDEN 1 • NEW JERSEY

FABRICATORS OF duPont TEFLON, Kellogg KEL-F AND OTHER PLASTICS

Representatives in Principal Cities Throughout the World

zine in a steam generating system, about 200% in excess of the equivalent dissolved oxygen in the feedwater may be fed. After the system is conditioned with hydrazine, this initial dosage can be cut back almost to the theoretical value (1 lb. N_2H_4 to remove 1 lb. O_2). General indications to date are that there is little difference between the cost per day of hydrazine versus sodium sulfite in boiler operation.

If 700 to 800% excess hydrazine is added to the feedwater, ammonia will be formed and carried over with the steam. If the pH of the condensate, due to ammonia alone, exceeds 8.5, corrosion of admiralty metal tubes in condensers and heat exchangers will occur. Correct dosage and control of hydrazine is therefore essential for proper results . . .

E. R. WOODWARD
Market Development Dept.
Mathieson Chemical Corp.
Baltimore, Md.

Insulation Chart

TO THE EDITOR: We would very much appreciate having you clarify the next to the last paragraph ["Graph Aid in Specifying Insulation," January, 1954, pp. 99-100], from which we quote: "Temperature of the outside insulation surface is assumed at 120° F. in converting mean temperature to hot surface temperature in Equation (2)." Please furnish a numerical example.

E. W. CLARKE
Blaw-Knox Co.
Chemical Plants Division
Pittsburgh 30, Penna.

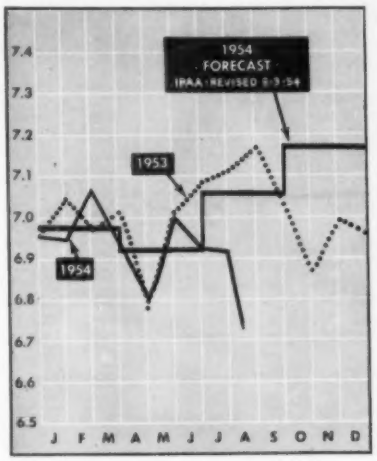
• *Here is your answer, Reader Clarke, as provided by J. M. Barhnart, executive director, Industrial Mineral Fiber Institute, Inc.:*

"In the make-up of the alignment chart, some expression had to be obtained for the heat loss per hour in Btu/sq.ft., including an expression which would depict a mean coefficient of thermal conductivity in terms of hot face temperature. The expression, $k = 0.252 + 0.00035\ t$, where t is the hot surface temperature, ° F., most nearly describes the above.

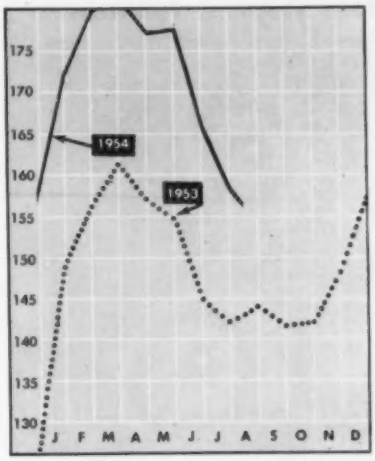
"For example, suppose a hot surface temperature is 600° F., with 3 in. of mineral wool blanket insulation desired; then $k = 0.252 + 0.0035\ (600) = 0.462$; and $u = [600 - 80]/[3/0.462) + (1/2)] = 520/(6.5 + 5) = 74.4$ Btu /hr./sq. ft. This value checks the chart.

"The mean temperature of 600° F. hot face and 120° F. outside temperature of outside of the insulation surface is 360° F., for which the mean k is 0.46 Btu-in./hr.-sq.ft.-° F."

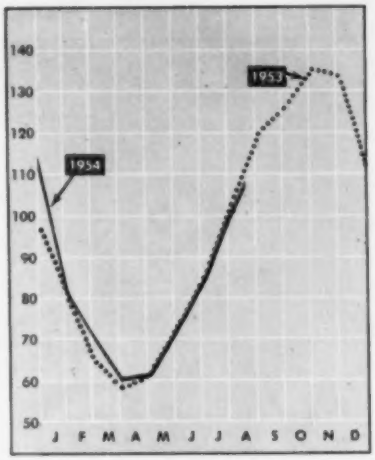
(To obtain more data on advertised products see page 1464)



CRUDE RUNS TO STILLS
(Millions of b/d, monthly averages)



PRIMARY GASOLINE STOCKS
(Millions of bbls., end of month)



PRIMARY DISTILLATE STOCKS
(Millions of bbls., end of month)

Cut in Runs Improves Inventories

OUTLOOK: Crude runs are likely to continue on a reduced level. Gasoline stocks by late fall may approach 1953 levels—Cold days will find heating oil inventories adequate except perhaps on the Gulf Coast.

General: Further announcements by oil companies of reductions in runs to still and also in their requirements of crude from Texas in September, indicate that refinery operations in general will remain about at the level of early August.

Refinery runs for July and early August were around 6,900,000 b/d avg., about 2.8% less than in the same weeks in 1953, and well under the spring forecasts of what volume of oil would be processed in this period. The slackening in operations is general in the major refining districts. Improvement in the wholesale gasoline market is already noticeable.

Gasoline: The reduced rate of refinery operations starting with the third quarter has substantially stepped up the withdrawals of gasoline from refiners' storage. In six weeks in July and early August, total drafts for the U.S. were over 11,000,000 bbls., while in the corresponding period last year they were only 4,172,000 bbls. Thus in place of a surplus of gasoline stocks, late in June, of 21,000,000 bbls. over those at the same date in 1953, inventories Aug. 6 totaling 156,808,000 bbls., were only about 15,000,000 bbls. higher than on Aug. 8, 1953.

The present curtailment of crude runs has resulted in reducing refinery gasoline output about 55,000 b/d from the same period last year. Thus, even without any large increase in demand from last year, if plant operations continue on the present scale, the smaller current output should lead to continued sizeable reductions in stocks.

Heating Oils: The reduction in crude runs has so far resulted in cutting plant output of heating oils (kerosine and distillates) by about 40,000 b/d. The stocks buildup at refineries has been at the same rate as in 1953 and the U.S. total of 137,-616,000 bbls. Aug. 6 was close to the figure for Aug. 8, 1953. The distribution over the country differs in that the combined East and Gulf Coast districts Aug. 6 were some 5,700,000 bbls. less than a year ago, while the Ind.,-Ill.-Ky. district was 4,500,000 bbls. higher.

KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbls. at end of month)

	Aug. 1954*	July 1954	Aug. 1953
CRUDE OIL			
U. S. Production	6.156	6.282	6.583
Imports	.686	.686	.672
U.S. Stocks	279.824	279.744	285.352
Runs to Stills	6.739	6.922	7.163
GASOLINE			
Refinery Output	3.377	3.378	3.518
Refinery Demand	3.624	3.732	3.544
Primary Stocks	156.328	158.174	144.238
HEATING OILS			
Refinery Output	1.700	1.716	1.724
Refinery Demand	1.054	1.094	1.053
Primary Stocks	141.031	132.636	154.351
RESIDUALS			
Refinery Output	1.078	1.108	1.222
Imports	.226	.277	.239
Total Supply	1.304	1.385	1.461
Refinery Demand	1.232	1.250	1.411
Primary Stocks	55.673	54.735	50.007

*Through Aug. 13, except Crude Stocks, which are B. of M. data one day later.

PRODUCT AND CRUDE PRICES

Products—¢ gal., weighted average prices in principal refinery markets
Crudes—$/bbl., principal fields
Source—Platt's Oilgram Price Service

	Aug. 1954*	July 1954	Aug. 1953
Gasoline	11.43	11.43	12.46
Distillates	8.72	8.66	8.99
Kerosine	10.24	10.25	10.32
Residuals	3.79	3.71	3.91
Above 4 Products	8.67	8.64	9.27
Lube Oils	16.30	16.52	18.35
Crude	2.81	2.81	2.84

REFINERY YIELDS

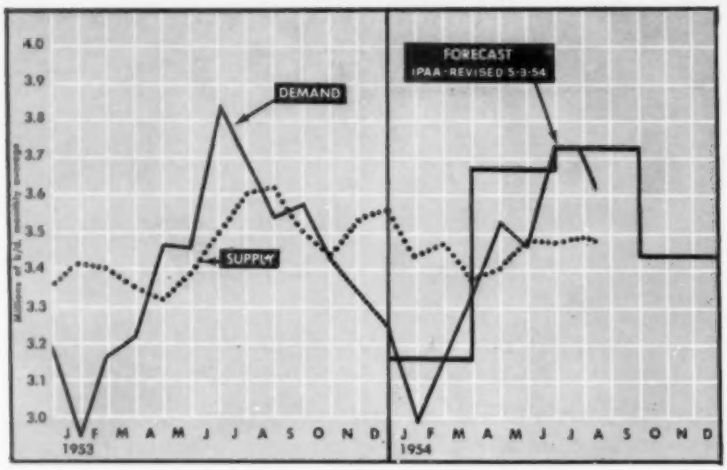
% on Crude Runs to Stills

	Aug. 1954*	July 1954	Aug. 1953
Gasoline	45.3	44.4	44.5
Kerosine	4.1	4.4	4.1
Distillates	21.1	20.4	19.8
Residuals	16.0	16.0	17.0

*Through Aug. 13.

SOURCE OF DATA (except prices): June, July and Aug., API weekly reports; earlier months, Bureau of Mines

Motor Fuel Shipments Close to '53 Level

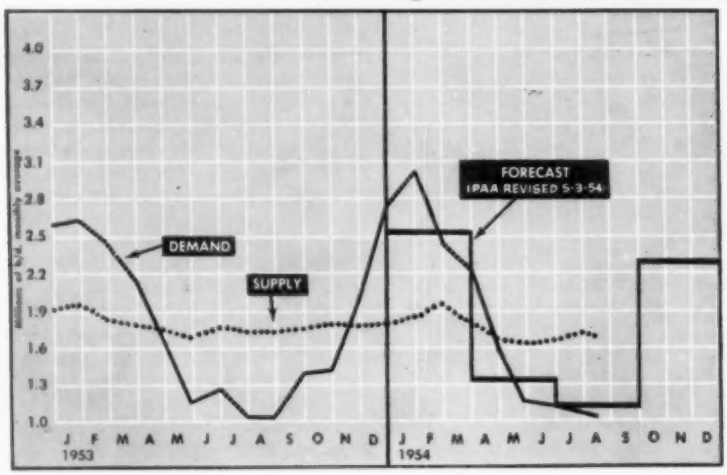


MOTOR FUEL

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
Aug. '54*	3.052	.430	3.482
Aug. '53	3.211	.403	3.614
Change	—.159	+.027	—.132
% Change	5.0	6.7	3.7
DEMAND (including Exports) (Millions of b/d)			
Aug. '54*			3.624
Aug. '53			3.544
Change			+.080
% Change			2.3
TOTAL SUPPLY (Millions of bbls.)			
7 Mos. '54	643.809	87.111	730.920
7 Mos. '53	646.074	80.947	727.021
Change	—2.265	+6.164	+3.899
% Change	0.3	7.6	5.4
TOTAL DEMAND (including Exports) (Millions of bbls.)			
7 Mos. '54			726.253
7 Mos. '53			720.056
Change			+6.197
% Change			0.9

*Through Aug. 13.

Heating Oil Demand Still on Bottom

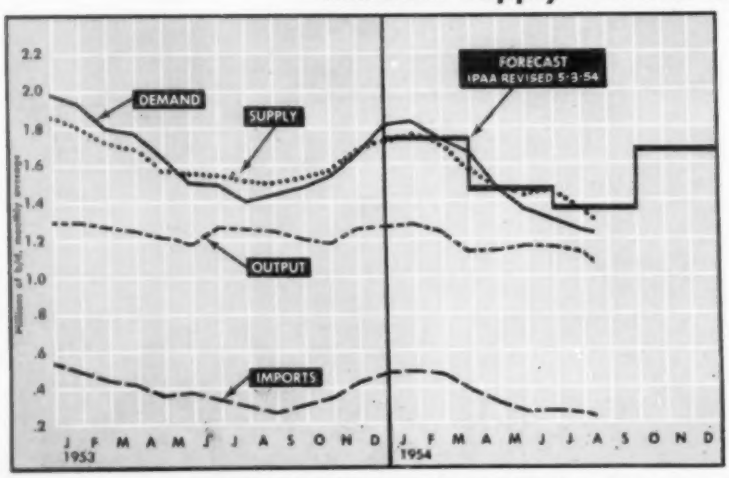


HEATING OILS

	Kerosine	Dist. Fuels	Total
PRODUCTION (Millions of b/d)			
Aug. '54*	.278	1.422	1.700
Aug. '53	.298	1.426	1.724
Change	—.020	—.004	—.024
% Change	6.7	0.3	1.4
DEMAND (including Exports) (Millions of b/d)			
Aug. '54*	.157	.897	1.054
Aug. '53	.156	.897	1.053
Change	+.001	—.000	+.001
% Change	0.6	0.0	0.0
TOTAL PRODUCTION (Millions of bbls.)			
7 Mos. '54	71.774	303.080	374.854
7 Mos. '53	72.921	307.781	380.702
Change	—1.147	—4.701	—5.848
% Change	1.6	1.5	1.5
TOTAL DEMAND (including Exports) (Millions of bbls.)			
7 Mos. '54	68.938	302.383	371.321
7 Mos. '53	69.417	307.886	377.303
Change	—.479	—5.503	—5.982
% Change	0.7	1.8	1.6

*Through Aug. 13.

Residual Supply-Demand Slips Off



RESIDUAL FUELS

	Refinery Output	Imports	Total
SUPPLY (Millions of b/d)			
Aug. '54*	1.078	.226	1.304
Aug. '53	1.222	.239	1.461
Change	—.144	—.013	—.157
% Change	11.8	5.4	10.7
DEMAND (including Exports) (Millions of b/d)			
Aug. '54*			1.232
Aug. '53			1.411
Change			—.179
% Change			12.7
TOTAL PRODUCTION (Millions of bbls.)			
7 Mos. '54	249.405	76.568	325.973
7 Mos. '53	263.935	81.704	345.639
Change	—14.530	—5.136	—19.666
% Change	5.5	6.3	5.7
TOTAL DEMAND (including Exports) (Millions of bbls.)			
7 Mos. '54			322.383
7 Mos. '53			350.169
Change			—27.786
% Change			7.9

*Through Aug. 13.

SOURCE OF DATA: June, July and Aug., API weekly reports; earlier months, Bureau of Mines

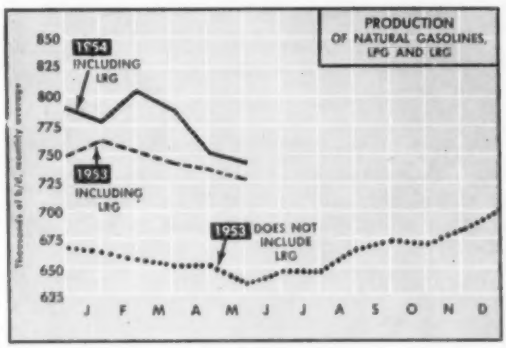
RUNS TO STILLS and DISTRIBUTION OF PRIMARY STOCKS BY U. S. REFINERY DISTRICTS

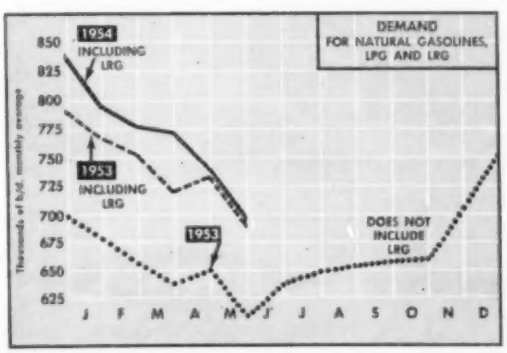
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Aug. 13 1954	Aug. 14 1953	Change	% Change	GASOLINE STOCKS (Millions of bbls., on date shown) Aug. 13 1954	Aug. 14 1953	Change	% Change	RESIDUAL STOCKS (Millions of bbls., on date shown) Aug. 13 1954	Aug. 14 1953	Change	% Change
East Coast	1.027	1.063	— .036	3.4	35.423	34.199	+ 1.224	3.6	11.606	12.773	—1.167	9.1
Gulf Coast	2.142	2.225	— .083	3.7	26.805	25.459	+ 1.346	5.3	7.258	9.038	—1.780	19.7
Total Coastal	3.169	3.288	— .119	3.6	62.228	59.658	+ 2.570	4.3	18.864	21.811	—2.947	13.5
Appalachian	.188	.197	— .009	4.6	6.627	4.932	+ 1.695	34.4	.822	.895	— .073	8.2
Ind.-Ill.-Ky.	1.301	1.314	— 013	1.0	35.868	28.064	+ 7.804	27.8	4.854	4.484	+ .370	8.3
Okla.-Kans.-Mo.	.587	.618	— .031	5.0	15.872	15.009	+ .863	5.7	1.204	1.211	— .007	0.6
Other Inland	.576	.649	— .073	11.2	16,875	14.106	+ 2.769	19.6	2.268	2.807	— .539	19.2
Total Inland	2.652	2.778	— .126	4.5	75.242	62.111	+13.131	21.1	9.148	9.397	— .249	2.6
Total East of Calif.	5.821	6.066	— .245	4.0	137.470	121.769	+15.701	12.9	28.012	31.208	—3.196	10.2
California	.914	1.026	— .112	10.9	18.858	19.976	— 1.118	5.6	27.661	19.025	+8.636	45.3
Total U. S.	6.735	7.092	— .357	5.0	156.328	141.745	+14.583	10.3	55.673	50.233	+5.440	10.8

District	DISTILLATE STOCKS (Millions of bbls., on date shown) Aug. 13 1954	Aug. 14 1953	Change	% Change	KEROSINE STOCKS (Millions of bbls., on date shown) Aug. 13 1954	Aug. 14 1953	Change	% Change	TOTAL HEATING OIL STOCKS (Millions of bbls., on date shown) Aug. 13 1954	Aug. 14 1953	Change	% Change
East Coast	35.761	37.948	—2.187	5.8	13.134	13.148	— .014	0.1	48.895	51.096	—2.201	4.3
Gulf Coast	17.013	21.409	—4.396	20.5	6.364	6.103	+ .261	4.3	23.377	27.512	—4.135	15.0
Total Coastal	52.774	59.357	—6.583	11.1	19.498	19.251	+ .247	1.3	72.272	78.608	—6.336	8.1
Appalachian	2.474	1.821	+ .653	35.9	1.033	1.053	— .020	1.9	3.507	2.874	+ .633	22.0
Ind.-Ill.-Ky.	22.512	18.947	+3.565	18.8	8.434	7.774	+ .660	8.5	30.946	26.721	+4.225	15.9
Okla.-Kans.-Mo.	11.960	12.001	— .041	0.3	1.895	2.291	— .396	17.3	13.855	14.292	— .437	3.1
Other Inland	5.547	5.333	+ .214	4.0	1.849	1.396	+ .453	32.4	7.396	6.729	+ .667	9.9
Total Inland	42.493	38.102	+4.391	11.5	13.211	12.514	+ .697	5.6	55.704	50.616	+5.088	10.1
Total East of Calif.	95.267	97.459	—2.192	2.2	32.709	31.765	+ .944	3.0	127.976	129.224	—1.248	1.0
California	12.659	12.710	— .051	0.4	.396	.402	— .006	1.6	13.055	13.112	— .057	0.4
Total U. S.	107.926	110.169	—2.243	2.0	33.105	32.167	+ .938	2.9	141.031	142.336	—1.305	0.9

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	May 1954	Apr. 1954	May 1953
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	304	313	295
Natural Gasoline and Isopentane	268	263	249
Condensate	28	31	24
Finished Gasoline, Naptha and Others	57	54	69
Total Natural Gasoline and Cycling Plant Production	657	661	637
Liquefied Refinery Gases	90	89	90
Total Marketable Gas Liquids	747	750	727
Lease Condensate	101	105	92
Total Natural Gas Liquids	848	855	819
CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	345	380	353
Natural Gasoline, Isopentane and Other	350	358	336
Total Current Demand	695	738	689

CUMULATIVE PRODUCTION (1000 bbls.)	May 1954	May 1953
LPG and LRG	64,457	60,738
Natural Gasoline, Isopentane and Other	52,332	51,905
Total Marketable Gas Liquids	116,789	112,643
CUMULATIVE DEMAND (1000 bbls.)		
LPG and LRG	61,474	59,050
Natural Gasoline, Isopentane and Other	52,594	51,433
Total Cumulative Demand	114,068	110,483

STOCKS (1,000 bbls., end of Month)	May 1954	Apr. 1954	May 1953
LPG and LRG	7,460	5,942	3,595
Natural Gasoline, Isopentane and Other	4,626	4,529	4,927
Total Stocks	12,086	10,471	8,522

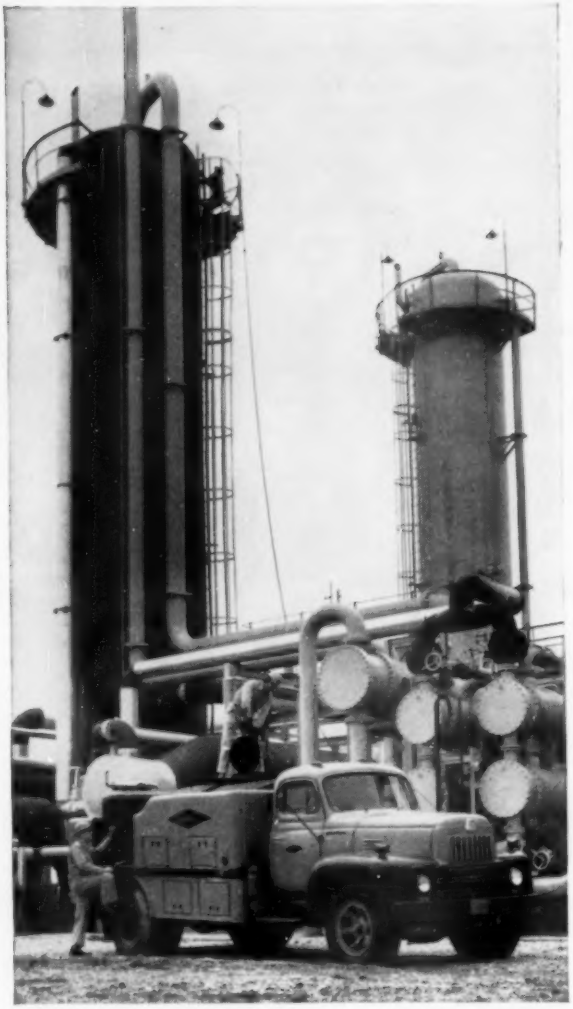
MILL SCALE REMOVED CHEMICALLY FROM NEW PLANT EQUIPMENT

Entire ammonia plant cleaned after erection. Job done in 4 days, cutting operator's estimated cleaning cost almost 50%.

A new synthetic ammonia plant had just been erected. The operator wanted to remove the mill scale from the entire operating system before the plant was put into production. This would eliminate dangers of product contamination, retarded heat transfer and further corrosion. And once the plant was put into operation, it could stay on stream.

Dowell engineers did the job in just 4 days. They used chemical solvents to remove the mill scale from all equipment in the ammonia, oxygen and lube systems—compressors, after-coolers, intake, discharge, hydraulic and synthesis lines, nitrogen knockouts, synthesis and raschig ring towers, and ammonia bowls. Solvents were applied through regular connections—no dismantling was required.

The operator indicated that Dowell Service saved his company almost 50% over their own estimated cost of removing the scale using mechanical methods.



Dowell engineers apply their wide chemical experience to your problems.

Dowell engineers do the job for you. They bring chemical solvents in truck-mounted tanks right to the job. They furnish all necessary pumping and control equipment. Solvents are applied according to the techniques demanded by the job: filling, spraying, jetting, cascading or vaporizing. These liquid solvents go wherever steam and water flow, reaching surfaces inaccessible to other cleaning methods. No special scaffolding is required. *There is usually no dismantling, and downtime is held to a minimum.*

Perhaps chemical cleaning can help increase the efficiency of equipment in your plant. For complete information and cost estimates, call your nearest of over 130 Dowell offices—no obligation, of course. If you prefer, write directly to DOWELL INCORPORATED, TULSA 1, OKLAHOMA, Department 1-32.

DOWELL SERVICE

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

DU PONT REG. U.S. PAT. OFF.

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT REG. U.S. PAT. OFF.

September ★ *One of a Series of Interest to the Petroleum Industry* ★ *1954*

This new booklet helps dealers answer customer complaints on poor power

How do your dealers react when a customer complains that the gasoline they sell lacks power? Do they lose the customer? Or are they able to counter with some ready and convincing sales ammunition?

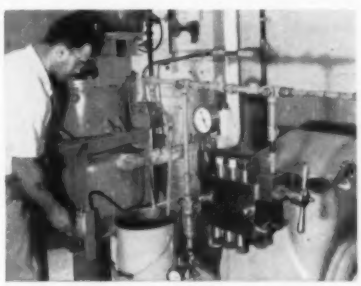
If they have trouble answering these complaints in a way that keeps the customer coming back, the four-page folder shown above can be a big help to them. It describes the many mechanical troubles that can cause power loss . . . such as poor spark plug condition, improper distributor or carburetor settings, leaky intake manifold and the various factors contributing to low compression. And it discusses them in a simple, easy-to-understand style.

Ask any Du Pont Petroleum Chemicals Division representative for a sample copy, and for information on obtaining them in quantities for your dealers.

New Silica Grease Thickener Announced

Here is a *new type* of grease thickener!

This new additive, Estersil GT, is quite different from any thickener



IN THIS PILOT PLANT at the Du Pont Petroleum Laboratory, we will be glad to help you formulate improved greases with Estersil GT and your own oil stocks.

previously used in commercial grease production. It is made by Du Pont and sold exclusively by the Du Pont Petroleum Chemicals Division.

Chemical "Raincoat"

The new material, an estersil, is a pelletized form of finely divided amorphous silica. One of its outstanding properties is a water repellent "raincoat" which is chemically attached to each tiny particle.

This chemically bonded "raincoat" means that you can now make a grease with unusual resistance to washout or breakdown in the presence of water.

Synthetically Made

Estersil GT is completely synthetic. And it was specially developed by Du Pont for grease compounding. With it, you can easily prepare a unique *multi-purpose* grease that will give remarkable endurance on even the most gruelling assignments.

In addition to water resistance, your greases made with Estersil GT will show unusually high thermal stability, superior oxidation stability, and exceptional shear stability under both normal and high temperature conditions. They possess superior handling qualities, too.

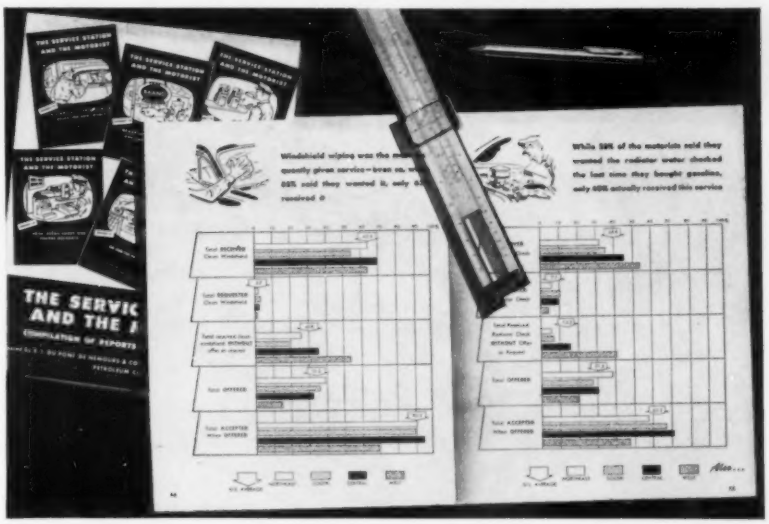
For more information and free samples of Estersil GT, address your request to our Wilmington office.

YOUR CUSTOMERS TOLD US!...

And we have now published their preferences in a single volume to help you evaluate services and promotions.

During the past year and a half we have published six different reports on the extensive Du Pont survey of service station customer buying habits and preferences. But the demand for these individual reports has far exceeded the supply.

Now, to help catch up with the demand and to provide marketing men with the over-all story in one handy reference book, we have combined all the reports into a single volume for selective distribution.



YOUR CUSTOMERS ARE AN "OPEN BOOK" when you keep handy a copy of this Du Pont survey report, "The Service Station and the Motorist."

The new book covers many different aspects of oil company marketing and customer purchasing habits. And it is arranged in chapters according to the following breakdown:

1. Selection of the service station and customer loyalty to the station.
2. Brand name recognition

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Survey Report*

and loyalty to brand.

3. Knowledge of gasoline grades and reasons for purchase.
4. Price, credit cards and charge accounts.
5. Oil and TBA purchases.
6. Services wanted by the motorist, asked for by the motorist, and given by the dealer.

By providing you with an accurate reading of customer preferences, this new book can help you tailor promotions for maximum effectiveness and efficiency.

How It Was Done

The survey is the result of thousands of household interviews with service station customers . . . and many more thousands of actual observations at the pump island where purchases are made. The interviews show what customers *think* and *say* about your products and dealer services. The observations, taken at 1,193 different service stations, show what customers *actually do* when making a purchase. The survey itself, which was conducted by National Analysts, Inc., is completely impartial.

Regional and Seasonal Breakdowns

National in scope, the survey is so organized that the findings can be analyzed according to region—for the four main marketing areas of the country. Separate breakdowns by sex, income and age of the respondents are also included, as well as breakdowns for age and price of car.

What's more, the service station observations are catalogued according to seasons – and based on about 6,000 observations during each of the four seasons.

In addition to the one-volume report, the complete information collected by this survey is recorded on IBM cards. Thus, it can be cross-tabulated to provide a wide variety of specialized breakdowns.

As such, we believe this Du Pont survey of consumer gasoline and TBA buying habits to be the most comprehensive, penetrating and accurate ever undertaken by any segment of the petroleum industry.

Special Distribution

Although the new one-volume report on this survey is not available to marketers all the way down the line, it will be distributed on request to marketing executives. And it is ideal . . . as reference material . . . for use by oil companies in preparing condensed marketing information for general dealer distribution.

SEATTLE DISTRICT MANAGER

ROBERT E. HOLETON is the district manager in charge of sales for the Du Pont Petroleum Chemicals Division in Washington, Oregon, and Idaho. His headquarters are in Seattle.

He joined the Du Pont Company as a chemist in 1933. After a wide experience in a number of Du Pont laboratories and semi-works areas, Mr. Holeton was transferred to the Petroleum Chemicals Division in 1949.

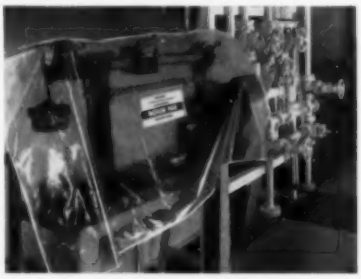
Prior to his present assignment in the newly created Seattle District, he was a sales-service representative in the Division's Eastern Region.

He is a graduate of Temple University and a member of the American Chemical Society.

ROBERT E. HOLETON

New Way to Protect Blending Plant Scales and Weightographs

A lightweight polyethylene cover is now available to you on request for protecting blending plant scales and weightographs during washdowns.



The new scale cover was specially designed for this purpose by Du Pont. It fits neatly and can be removed quickly.

A large card identifying the mix in the weigh tank appears on the facing side of the cover. Made in two sizes, the covers are designed to fit any blending plant scale installation.

The new scale covers have already been installed in many plants. Refiners using them report excellent results in helping prevent rust which may be caused by excessive moisture accumulation during blending plant washdowns. The scale covers also provide protection against corrosive action when equipment is not in use. And they have greatly improved housekeeping efficiency in blending plants where former makeshift covering required special handling.

For a cover to protect this equipment in your own blending plant, ask a Du Pont representative or send your request to the nearest Du Pont Petroleum Chemicals Division regional office.

DU PONT

Better Things for Better Living
. . . *through Chemistry*

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • *Wilmington 98, Delaware*

Regional Offices:
NEW YORK, N. Y.—1270 Ave. of the Americas Phone COlumbus 5-3620
CHICAGO, ILL.—8 So. Michigan Blvd. Phone RAndolph 6-8630
TULSA, OKLA.—1811 So. Baltimore Avenue Phone Tulsa 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. Phone PReston 2857
LOS ANGELES, CALIF.—612 So. Flower St. Phone MAdison 5-1691

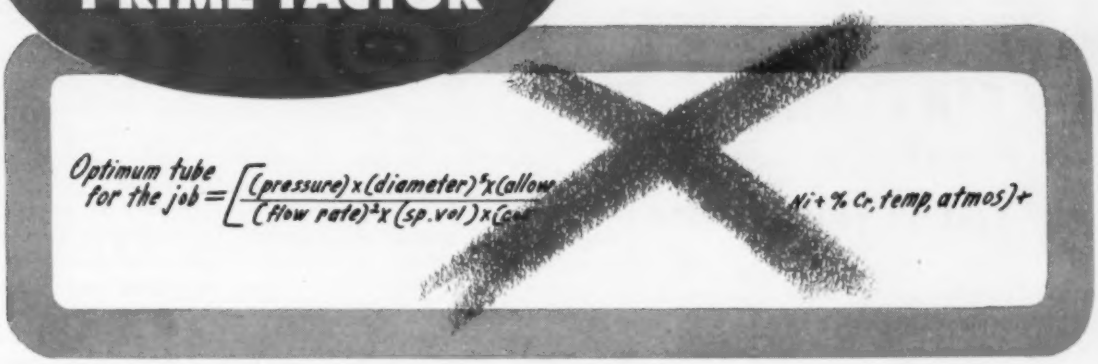
IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division, 80 Richmond Street West, Toronto 1, Ontario
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Bldg., 6539—Wilmington 98, Del.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-7872

Printed in U. S. A.

WHEN OXIDATION IS A PRIME FACTOR



Tube Selection Cannot be Reduced to a Formula

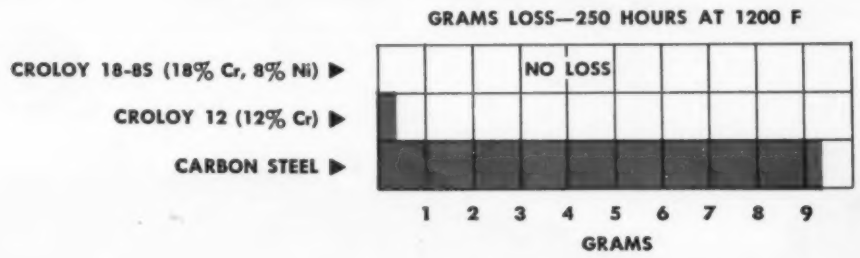
—even a complicated one

When any metal is exposed to high temperatures, it burns. Slow burning is called oxidation and in the process scale forms on the metal being burned. If the process continues the scale will flake off, causing loss of metal.

One of the major benefits resulting from alloying chromium with iron is greatly increased resistance to oxidation at high temperatures. A tight surface layer of chromium-rich oxide is formed and this layer retards oxygen diffusion. Tests have shown that resistance of chromium alloy steel to oxidation is directly proportional to the chromium content of the alloy. The chart below compares relative oxidation resistance at 1200 F of stainless and carbon steels, as determined by scale loss on heating 250 hours.

But only an expert can properly evaluate all of the elements that make up the best analysis to match the requirements of your specific tubing application. There is no substitute for the kind of experience with these problems you'll find at B&W.

To get the most benefit from B&W's long experience in matching tubes to jobs, call on Mr. Tubes, your nearby B&W Tube Representative. He can help you make the best choice.



THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

B&W SEAMLESS and WELDED TUBES

TA-4060(P)

THESE 72 FIRMS

have bought one or more

FLUOR FIN-FAN

AIR-COOLED HEAT EXCHANGER

within the past 13 years

The firms listed on this page, and many others, have bought Fluor Fin-Fans since they were first introduced in 1941. Customer acceptance is indicated by the number of repeat orders — over 50% of these firms have repurchased Fluor Fin-Fans, and several of them have used no other heat transfer equipment. Investigate Fluor Fin-Fans for dependable waterless cooling, and join this list of satisfied users.

Write for your copy of the **FLUOR FIN-FAN** *Bulletin* **FF-FD-0.002**

* A. T. & S. F. RAILWAY
* ALUMINUM COMPANY OF AMERICA
* AMARILLO OIL COMPANY
ATLANTIC REFINING COMPANY
BARNHART HYDROCARBON CORP.
* BLAW-KNOX COMPANY
* BOROUGH OF ASPINWALL
BOROUGH OF GROVE CITY
BROOKLYN UNION GAS COMPANY
CHICAGO CORPORATION
* CITIES SERVICE OIL COMPANY
* CITIES SERVICE GAS COMPANY
COLOMBIAN PETROLEUM CO.
* COLORADO INTERSTATE GAS CO.
* COOPER-BESSEMER
COPRA OIL & MEAL COMPANY
* COSDEN PETROLEUM COMPANY
DRESSER ENGINEERING CO.
* EL PASO NATURAL GAS COMPANY
* EQUITABLE GAS COMPANY
GIRDLER COMPANY, THE
HOME GAS COMPANY
HONOLULU OIL CORPORATION
* HOPE NATURAL GAS COMPANY
* LOMITA GASOLINE COMPANY
* LONE STAR PRODUCING COMPANY
* MICHIGAN-WISCONSIN PIPE LINE CO.
MONTANA-DAKOTA UTILITIES
OHIO OIL COMPANY, THE
* OTHA H. GRIMES
PACIFIC NUT OIL COMPANY
* PEOPLE'S NATURAL GAS COMPANY
* PERMIAN BASIN PIPE LINE CO.
PHILADELPHIA ELECTRIC COMPANY
* PHILLIPS PETROLEUM COMPANY
PIONEER NATURAL GAS COMPANY
* RICHFIELD OIL CORPORATION
RUNNELS GAS PRODUCTS CORP.
SAN DIEGO GAS & ELECTRIC CO.
SAN JOAQUIN COTTON OIL CO.
* SHELL OIL COMPANY
SID RICHARDSON GASOLINE CO.
* SINCLAIR OIL & GAS COMPANY
SOHIO PETROLEUM
* SOUTHEASTERN PIPE LINE COMPANY
* SOUTHERN CALIFORNIA GAS CO.
* SOUTHERN COUNTIES GAS CO. OF CALIF.
* STANOLIND OIL & GAS COMPANY
STANDARD OIL COMPANY OF CALIFORNIA
* STANDARD-VACUUM OIL COMPANY
STAUFFER CHEMICAL COMPANY
* SUNRAY OIL CORP.
SYLVANIA CORPORATION, THE
* TENNESSEE GAS TRANSMISSION CO.
* TAYLOR OIL & GAS COMPANY
TEXAS COMPANY, THE
* TEXAS EASTERN TRANSMISSION CORP.
* TEXAS GAS TRANSMISSION CORP.
* TEXAS-ILLINOIS NATURAL GAS PIPE LINE
TIDE WATER ASSOCIATED OIL CO.
* TRANSCONTINENTAL GAS PIPE LINE CO.
* U. S. SPRING & BUMPER COMPANY
UNION GAS SYSTEM, INC.
UNION GAS COMPANY OF CANADA, LTD.
* UNION OIL COMPANY
* UNITED FUEL GAS COMPANY
* UNITED GAS PIPE LINE COMPANY
U. S. ARMY CORPS OF ENGINEERS
* WARREN PETROLEUM CORPORATION
WASHINGTON GAS LIGHT COMPANY
WESTINGHOUSE ELECTRIC
WEST VIRGINIA GAS CORP.

**Repeat customers who have bought more than one Fin-Fan.*

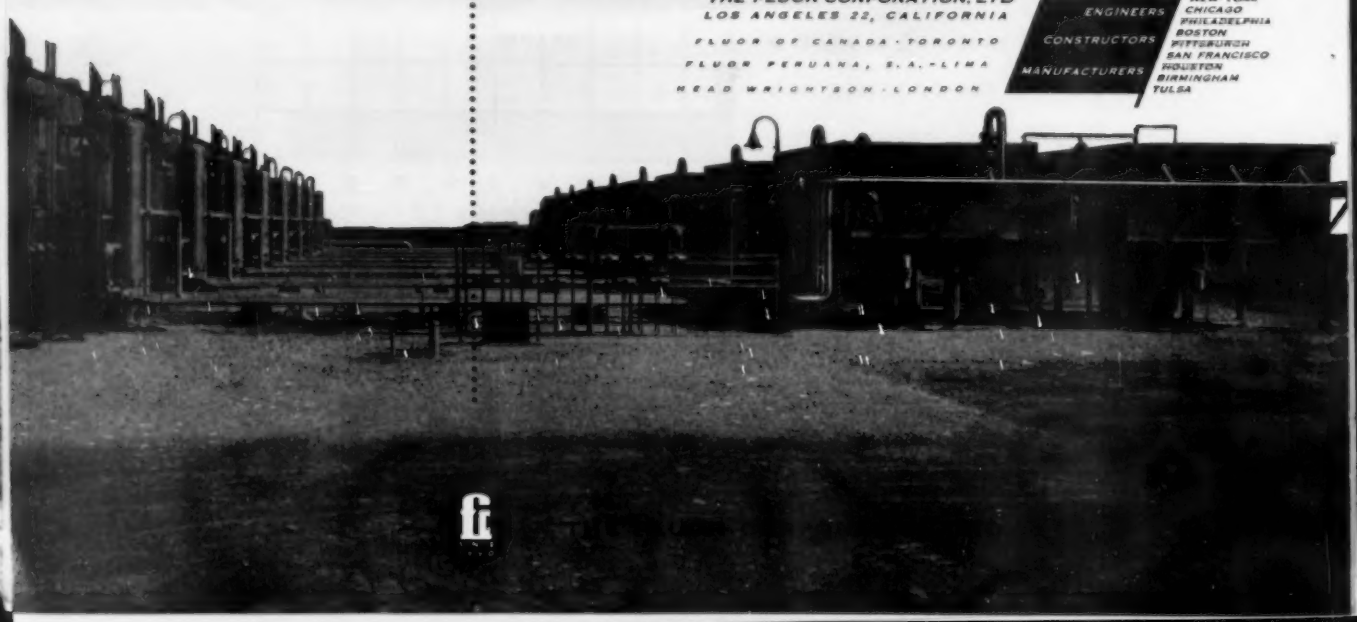
BE SURE WITH **FLUOR**

THE FLUOR CORPORATION, LTD
LOS ANGELES 22, CALIFORNIA

FLUOR OF CANADA · TORONTO
FLUOR PERUANA, S.A. · LIMA
HEAD WRIGHTSON · LONDON

ENGINEERS
CONSTRUCTORS
MANUFACTURERS

NEW YORK CHICAGO PHILADELPHIA BOSTON PITTSBURGH SAN FRANCISCO HOUSTON BIRMINGHAM TULSA



Report from

Brea Chemicals' New Ammonia Plant...

C. F Braun & Co., Engineers and Constructors

...on their **Air Products** *Low-Temperature*

LIQUID NITROGEN WASH UNITS

and Tonnage Oxygen-Nitrogen Generators

BREA CHEMICALS, INC.
P. O. BOX 128
BREA, CALIFORNIA

JACK TIELROOY
MANAGER OF DEVELOPMENT

Mr. C. J. Schilling,
Chief Engineer,
Air Products, Inc.
P. O. Box 538,
Allentown, Pa.

Dear Mr. Schilling:

Our ammonia plant has now been operating for some time, and we want to let you know that we are well-pleased with the nitrogen production units and hydrogen purification units you supplied to us.

The units produce nitrogen with a purity of 99.99% and hydrogen-nitrogen mixtures with a purity of better than 99.999% at rates considerably over "design".

The prompt availability of your engineers for consultation at the site was indeed a real assistance during our start-up and is very much appreciated. The help they gave us was of real assistance in achieving an early "on-stream" date.

Yours very truly,
BREA CHEMICALS, INC.
Jack Tielrooy
Jack Tielrooy,
Manager of Development

AIR PRODUCTS built two of these "Package" hydrogen purification units using nitrogen wash and two oxygen-nitrogen producing units for Brea Chemicals, Inc., a subsidiary of Union Oil Company of California. "Package" Nitrogen Wash Units are available from *Air Products* with capacities to 10,000,000 cubic feet per day. Larger plants with greater capacities are also available. Both types are designed and built to meet individual requirements.

For further information on hydrogen purification plants . . . oxygen-nitrogen generators . . . other low-temperature processing units for gas separation . . . write or phone *Air Products, Incorporated, Dept. L, Box 538, Allentown, Pa.*

Send for 36-page brochure, "Low-Temperature Processing"

Air Products
INCORPORATED

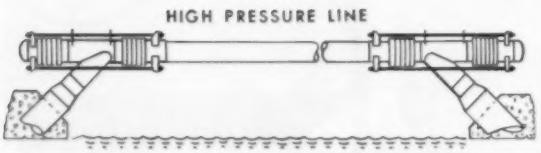
Specialists in Low-Temperature Processing

Badger

Expansion Joints

Typifying Joint Engineering at its Best

THE *"Balanced"* JOINT



Picture a pipe line not only "hot" but also under high pressure. At any point where the pipe line changes direction abruptly, two distinct problems are involved: the usual thermal expansion but equally important, the terrific thrust created by the line pressure. Some means must be provided for 'holding' the pipe which in most installations can be securely anchored to a supporting structure. There are cases however, when this is not possible.

How can such a problem be handled?

This "Balanced" joint was designed for just such unusual problems. The unit consists of two joints tied together with four heavy rods. One end of the unit which is anchored at the center is blanked off. The rods balance the internal pressure. Thus, the only force exerted on the intermediate anchor is the force required to open and close the joints.

During the past few years we have engineered a number of these "Balanced" joints. The joint illustrated above was designed for use on a turbine, where it was necessary to reduce the stresses on the turbine casing. In another typical case (see sketch) "Balanced" joints were used to relieve the stresses on a bridge carrying a high pressure gas main. The anchor force was reduced from 245,000 pounds to 14,000 pounds.

This same engineering skill and flexibility in thinking is back of the other special joints as well as standard packless, corrugated joints with which the name Badger has for so long been associated. These are the joints you can trust to serve you well.

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET · CAMBRIDGE 41, MASS.

"THE BRAND OF PROGRESS"

By Heat Exchanger Specialists

▲ SYNOPSIS OF AD #5: The purchasing department of Western Supply is charged with keeping the delicate balance between warehouse stocks of plate, tubes, channels, and flanges . . . and special materials requisitioned from outside sources. This balance is essential if maximum heat exchanger economy is to be achieved. The skill of Western's purchasers is proven in securing the high priced materials involved in alloy fabrication. Dollars saved through this experience are happily passed on to Western's customers.

sixth in a new series of advertisements

FIGHTING HEAT EXCHANGER CORROSION

. . . . With Experience in Special Metal Fabrication

Refining and chemical processing as we know them today have been made economically feasible by the development of heat transfer equipment.

Originally, heat exchanger design problems were simple but higher temperatures and pressures, combined with corrosive fluids have complicated the problem.

Today the experienced metallurgist and the trained welder form an indispensable team in Western Supply Company's heat exchanger plant. Corrosion and pitting may be controlled at the initial fabrication point through the skillful selection and fabrication of special metals.

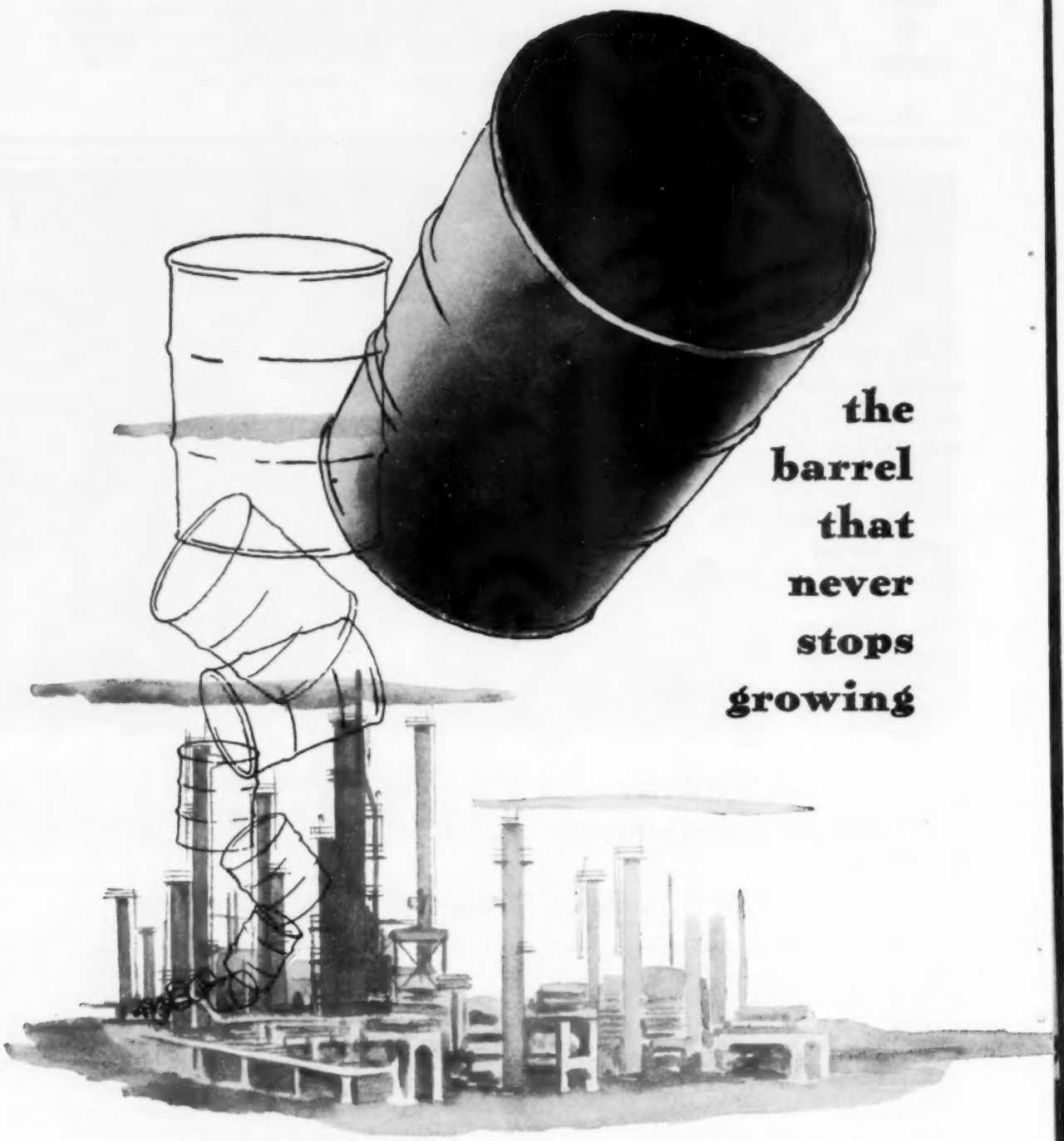
Western has exerted great care in the initial selection and subsequent building of its technical staff. In addition it has equipped this staff with the latest welding and stress-relieving equipment. Western's experience in alloy fabrication dates back many years and includes working in such metals as . . . AISI Stainless Steels in the 300 series . . . High Chrome Irons . . . the Refiner's Alloys, the low chrome Moly Steels . . . Monel . . . Copper Silicon . . . Copper . . . Nickel . . . Aluminum.

For heat exchangers on corrosive stream . . . consult with Western Supply Company.

WESTERN HEAT EXCHANGERS

WESTERN SUPPLY CO.

P. O. BOX 1888 • TULSA, OKLAHOMA


the
barrel
that
never
stops
growing

Since the discovery of oil, the petroleum refining industry has been constantly squeezing more and more useful products from every barrel of crude. The success of its work is best evidenced by the comparison of product recovery during the early days of refining with the volume of products now being obtained from today's barrel of petroleum.

Working cooperatively with the petroleum refining industry, Universal proudly points to its contributions that have helped provide better processing methods and more efficient refining techniques. All of these have been successfully applied to help the petroleum refiner realize a more profitable return on each dollar invested in processing equipment.

The research and development work conducted in Universal laboratories over a period of more than thirty-five years has been done for the benefit of the entire petroleum refining industry. The processes and products resulting from this work have been made available to every petroleum refiner. And they have been widely applied by refiners the world over.

To obtain better products, and to conserve one of our most vital natural resources, Universal will continue to develop improved methods for refining crude oil. More and more product must be obtained from each barrel of petroleum, yet volume alone isn't sufficient. Product quality must be constantly improved to provide every ounce of energy which every drop of oil is capable of producing. With this goal in mind, Universal will always continue to nourish The Barrel That Never Stops Growing.

UNIVERSAL OIL PRODUCTS COMPANY

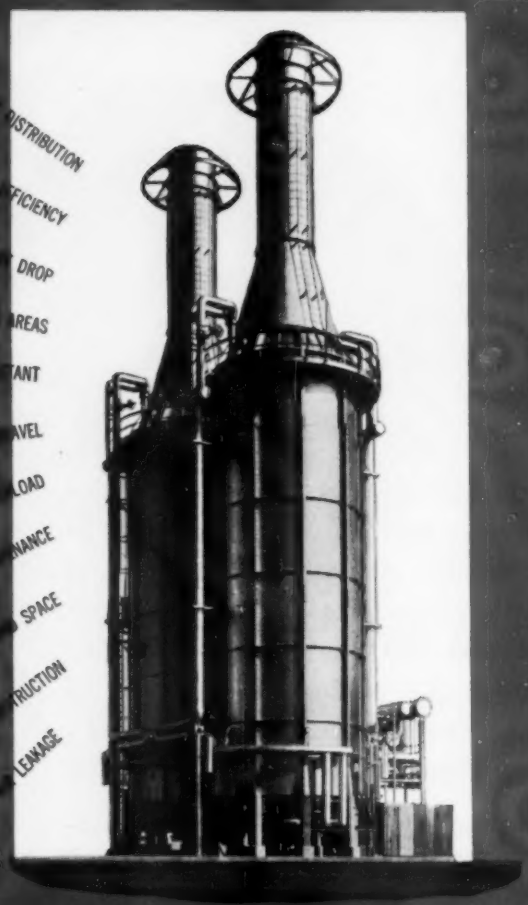
UOP

30 ALGONQUIN ROAD, DES PLAINES, ILL., U. S. A.

Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your ***Investment***

If yours is a fluid heating problem



EVEN HEAT DISTRIBUTION
MAXIMUM FUEL EFFICIENCY
LOW PRESSURE DROP
PLENUM CHAMBERS FOR HAZARDOUS AREAS
EXPLOSION RESISTANT
SHORT LENGTH OF LIQUID TRAVEL
EXCESS DRAFT FOR HIGH OVERLOAD
LOW MAINTENANCE
MINIMUM GROUND SPACE
SIMPLICITY OF DESIGN AND CONSTRUCTION
ZERO AIR LEAKAGE

PETROCHEM-ISOFLOW FURNACES

are most efficient by any comparison

MAXIMUM FUEL EFFICIENCY

1. The generic design of Iso-Flow heaters, **including the re-radiating cone,** gives excellent heat distribution and eliminates localized over-heating. **2.** All walls are protected by tubes which create low refractory wall temperatures. **3.** The refractories have high insulating characteristics which create minimum outside shell temperatures and, hence, exceedingly low radiation. **4.** With a radiant loss of under 2% more heat is absorbed by the fluid being heated. This results in higher efficiency for any type of Iso-Flow design. **5.** Since Petro-Chem designs include a wide variety of convection sections all heaters can be engineered for optimum fuel efficiency or for maximum fuel efficiency where the price of fuel and other economic considerations justify.

More than 1200 PETROCHEM-ISOFLOW FURNACES are in operation throughout the world in the petroleum, chemical and allied industries... for all processes and for any duty, pressure, temperature and efficiency ... and all Petrochem-Isoflow Furnaces are pre-eminently satisfactory.

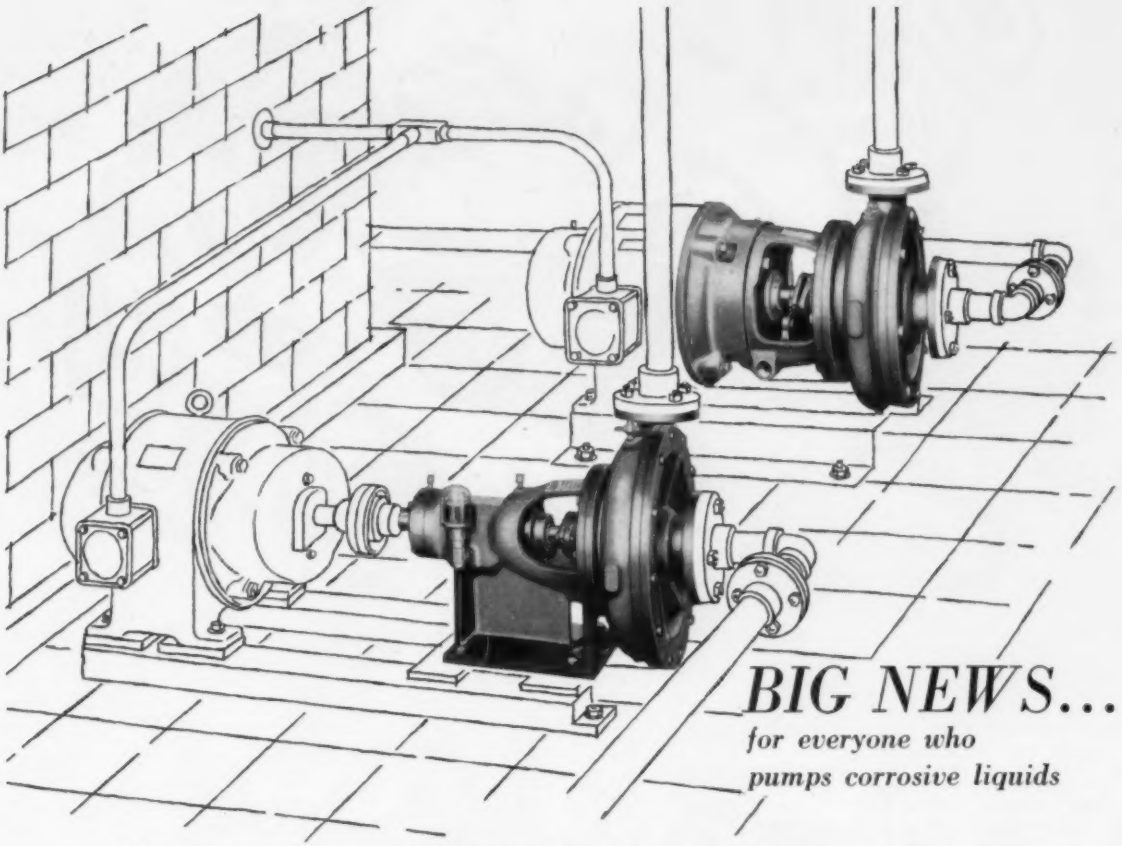
PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE ... CAPACITY ... DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 East 42nd St., New York 17, N. Y.

Representatives: Bethlehem Supply, Tulsa and Houston • Flagg, Brackett & Durgin, Boston • D. D. Foster, Pittsburgh • Faville-Levally, Chicago • Lester Oberholtz, Los Angeles • Gordon D. Hardin, Louisville • Turbex, Philadelphia (Narberth, Pa.)

Foreign Licensees: England – BIRWELCO, LTD., Birmingham 6 • France – HEURTEY & CIE, Paris • Germany – DR. C. OTTO & COMP., Bochum



BIG NEWS...

for everyone who pumps corrosive liquids

Now you can get the **"custom-built"** *features you want at no penalty with the new* **AMPCO* Centrifugal Pump**

In a given pump size, new standard units give at least 108 different combinations, plus maximum resistance to corrosion, erosion, cavitation

Here's low-cost corrosive liquid transfer at its new, versatile best. If you require pumps in flows up to 600 gpm, this new 1750 rpm pump is exactly right for you. It can be built to *your* special requirements by interchanging standard parts.

You can select the bearings you want — sealed, replenishable-grease, or oil-lubricated.

You can choose your shaft seals — inside or outside mechanical seals; internal, external, or flushing packed stuffing-boxes.

You can get the exact shaft you need — no compromising. Take your choice of general-purpose and extra-rigid shafts as well as a new two-piece unit that allows removal of the rotating parts without disturbing coupling, bearings, or alignment.

You can select the pedestal height and type impeller you want.

Best of all, you don't have to buy another pump when conditions change. You can make modifications quickly and inexpensively in the field — save yourself valuable time and money.

Corrosion damage? Forget it. These pumps are built entirely from Ampco or other workable alloys to combat the effects of corrosive acids, alkalis, organic chemicals, etc. And these pumps have many new design features — features that contribute to dependable, maintenance-free pumping.

The new Ampco 1750 rpm Pumps are now stocked for immediate delivery. Contact your Ampco Pump Distributor or Field Engineer or mail the coupon.

Ampco Metal, Inc.
Dept. PP-9, MILWAUKEE 46, WISCONSIN
West Coast Plant • Burbank, California

Fill out this coupon and mail today

AMPCO METAL INC., Dept. PP-9, Milwaukee 46, Wisconsin

The new Ampco Pump sounds good to me. Send me additional information. I pump.....

Name..... Title.....

Company.....

Company Address.....

City..... (.....) State.....

*Reg. U. S. Pat. Off.

Maximum Interchangeability without Penalty

P-13

 (To obtain more data on advertised products see page 1464)

LUCK . . . . OR SKILL?

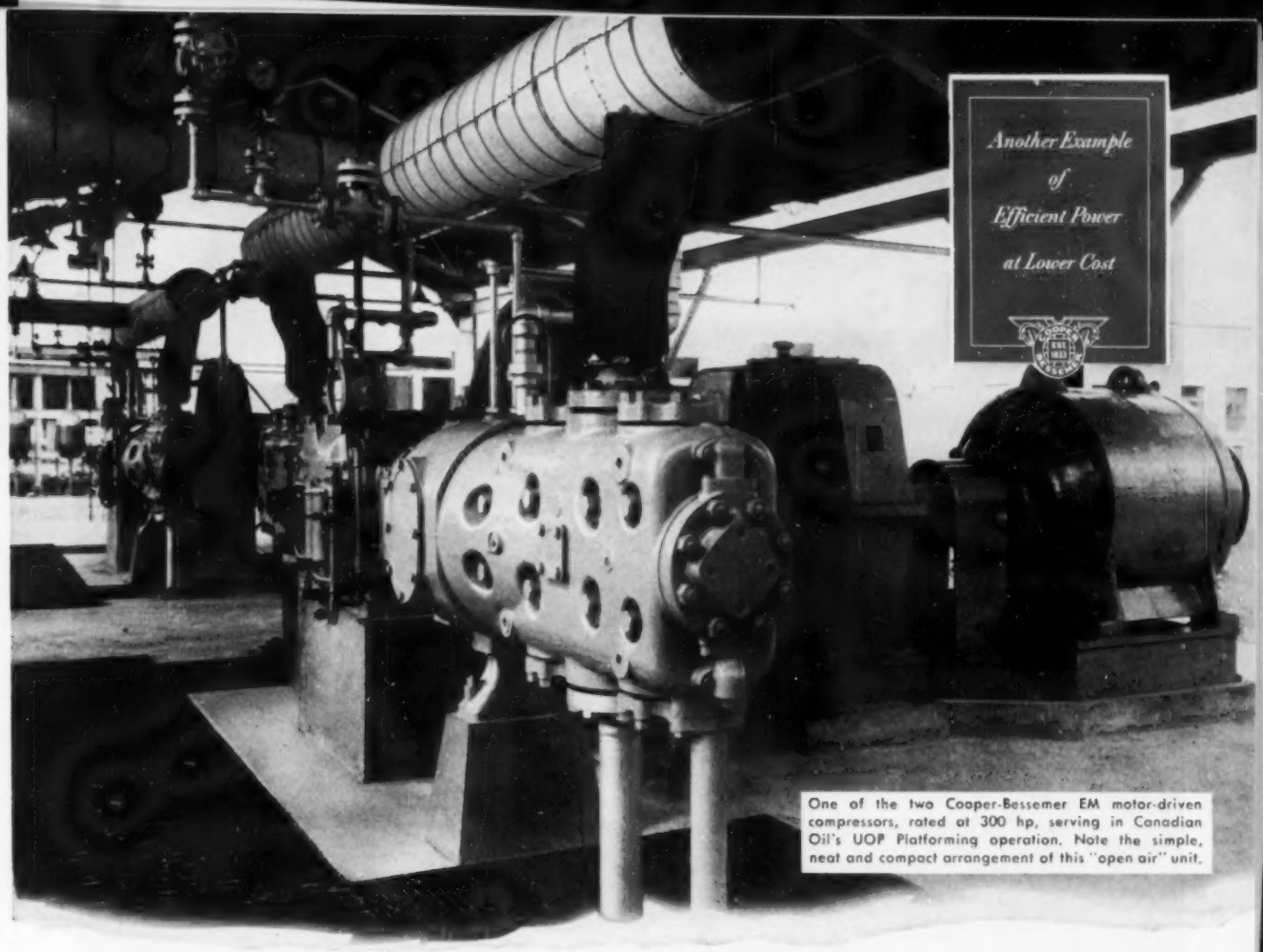
YOU can't tell from one shot. An expert marksman earns his rating by *repeated* hits. Here at McKee we have earned our reputation for doing a good job by repeatedly *doing a good job.*

McKee services mean correct design, sound engineering, expeditious purchasing and efficient construction . . . in short, a plant that's designed and built to earn a profit.

McKee Engineering Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York • Tulsa, Oklahoma • Union, N. J. • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 350 Bay St., Toronto



One of the two Cooper-Bessemer EM motor-driven compressors, rated at 300 hp, serving in Canadian Oil's UOP Platforming operation. Note the simple, neat and compact arrangement of this "open air" unit.

With CANADIAN OIL'S PLATFORMING UNIT... *a new high in compressor efficiency for high octane gasoline*

COOPER-BESSEMER 2-cylinder motor-driven M-Line compressors efficiently recycle hydrogen for the UOP Platforming unit in the Sarnia, Ontario, refinery of Canadian Oil Refineries, Ltd.

Cooper-Bessemer developed compressors with non-lubricated cylinders have permitted Canadian Oil Refineries to run its Platforming unit thousands of hours without any possibility of contaminating the recycle gas with lubricating oil.

Canadian Oil's Platformer is charging nearly 3800 barrels per stream day, and producing high yields of gasoline with an octane number reaching well into the 90's. In this process, Cooper-Bessemer EM's continue to play a vital and dependable role in the production of high octane gasoline.

If you are considering UOP Platforming, or compressor additions of virtually any type, Cooper-Bessemer offers more than a century of reliable compressor building experience. Contact our nearest office for detailed information.

MOUNT VERNON, OHIO

COOPER-BESSEMER

GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

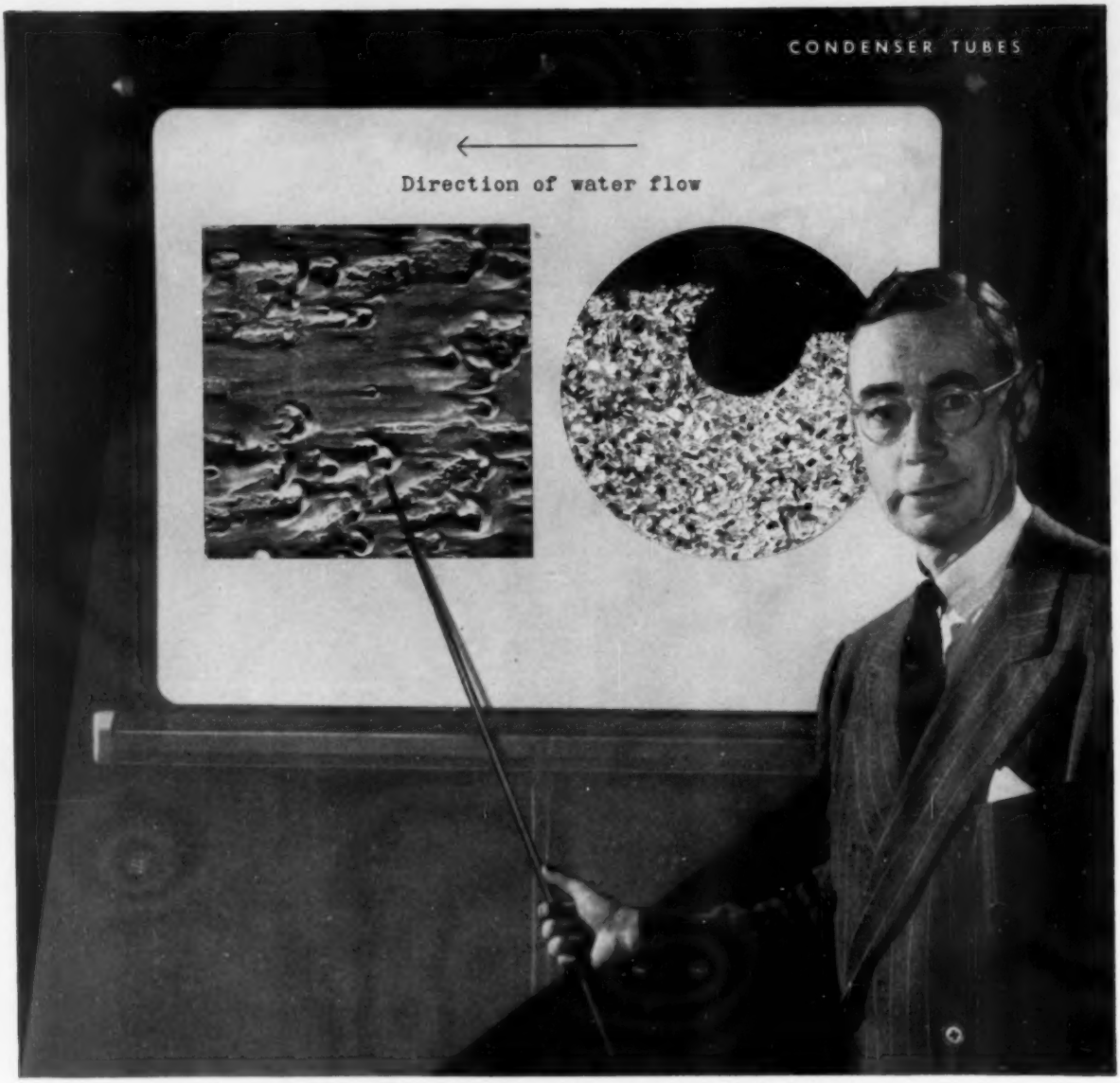


Illustration at left shows impingement corrosion of an Admiralty tube by high velocity sea water containing air bubbles. At right, longitudinal section through part of horseshoe-shaped pit is shown.

AIR BUBBLES: what causes them, how they affect condenser tubes

Before corrosion can occur, oxygen from the air dissolved in cooling waters must be present. But normally its presence doesn't cause *rapid* corrosion of condenser tubes.

What can cause rapid corrosion is air in the form of bubbles where turbulent flow is present. Whirlpools in the intake tunnel, leaky packing glands on pumps and at projections in injection pipes or water boxes may produce air bubbles of harmful size. Any condition that will produce a negative pressure at some point along a tube, such as a long outlet leg from a condenser, can cause air bubbles. Local pitting may then occur rapidly.

Air bubbles are only one factor affecting tube life. Publication B-2, "Anaconda Tubes and Plates for Condensers and Heat Exchangers," discusses *all* the important operational factors, and gives much other useful information. And, of course, our Technical Department stands ready to assist you in the selection of tube alloys from our extensive line. *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

54105

ANACONDA®

Tubes and Plates for Condensers and Heat Exchangers

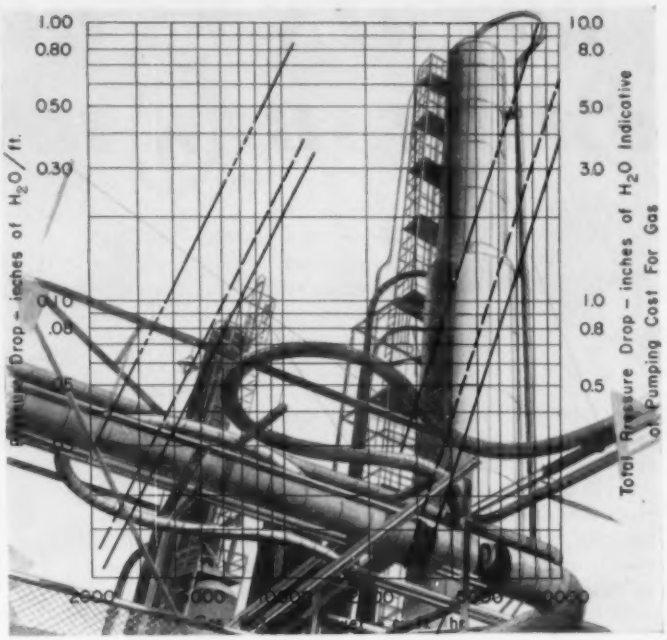
Arsenical Admiralty-439; Ambraloy-927; Cupro Nickel, 30%-702; and other copper alloys.*
*U. S. Patent No. 2,003,685 (Orig.)

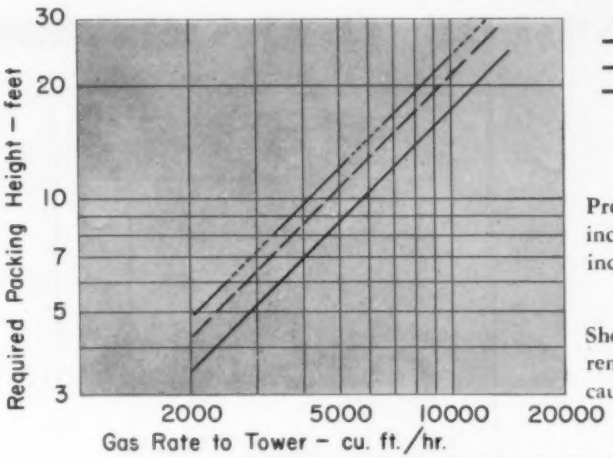
HOW INTALOX SADDLES CAN REDUCE TOWER HEIGHT AS MUCH AS 30%

If your choice of a tower filling is based on what packing will, for an equivalent through put, be most economical in both initial tower investment and operating costs — take a look at these charts and their accompanying table.

This is another typical demonstration of the striking savings that can be made through the use of Intalox saddles. It is based on observed capacity data in a pilot plant operation where CO_2 is removed from an inert atmosphere using a dilute aqueous caustic solution.

It will pay you to analyze tower construction and operating costs in the light of greatly reduced tower height and weight. You'll quickly see why cost-conscious engineers are more and more frequently designing towers to use to the full pronounced advantages of Intalox saddles.





1" RASCHIG RINGS
1" BERL SADDLES
1" INTALOX SADDLES

Chart No. 1 (Above)

Pressure drop data comparison. Data shown both in inches of H_2O per foot, and total pressure drop in inches of H_2O.

Chart No. 2 (Left)

Showing comparison of packed height required for removal of CO_2 from an inert atmosphere using dilute caustic liquor as the scrubbing liquid.

COMPARATIVE STUDY BASED ON DATA SHOWN ABOVE

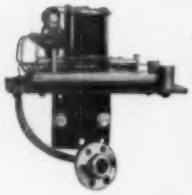
	Tower Crossection, Sq. Ft.	Required Packed Height* Ft.	Packing Weight Lbs.	Weight of Steel Shell—⅛" Thick	Weight Packing & Shell Lbs.	Total Column Hold-up Cu. Ft.	Pressure Drop—Inches of H_2O**
1" Raschig Rings	1.0	12.0	480	672	1152	0.76	2.0
1" Berl Saddles	1.0	10.5	473	588	1061	0.68	0.77
1" Intalox Saddles	1.0	8.6	293	482	775	0.68	0.47

* To remove 90% of the CO_2 from the gas; initial gas composition being the same in all cases.
** For a gas flow of 5,000 cu. ft./hr. and essentially atmospheric operation.

UNITED STATES STONEWARE CO.
Process Equipment Division AKRON 9, OHIO
NEW YORK CHICAGO HOUSTON

Now you can measure pressures

WITHIN ½% OF 20-40 PSI SHIFTABLE RANGE SPANS



The Taylor TRANSAIRE* Pressure Transmitter with short, shiftable spans gives accuracy and sensitivity never before thought possible—plus the convenience of suppressed ranges at high pressure levels. Operating on the simple force-balance principle, it lets you measure and transmit minute pressure changes up to 1,000 ft. It's accurate to ½% of the selected short range span, as against an accuracy of up to ½% of the upper range limit of conventional devices. On control applications such accuracy of measurement produces a remarkable difference in product quality and yield. It's sensitive to pressure changes of ½" water.

THREE IMPORTANT ADVANTAGES

1. Range spans of 20 and 40 psi are available throughout the range limits of 35 to 415 psia; 50 to 100 psi throughout 100 to 1,000 psia.

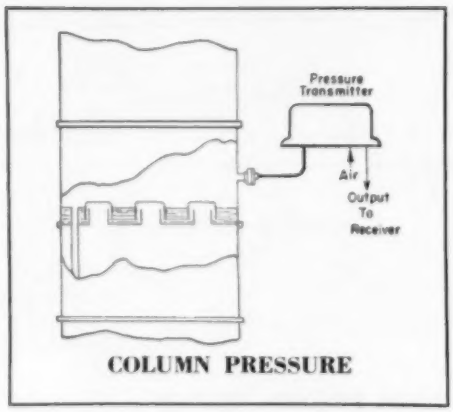
2. The volumetric type pressure system is extremely accurate, practically clog-proof, has a corrosion-resistant 316 stainless steel diaphragm.

3. Temperature and barometric compensation makes for higher accuracy of measurement, and consequntly closer control.

• • •

Ask your Taylor Field Engineer, or write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

TRANSAIRE PRESSURE TRANSMITTER



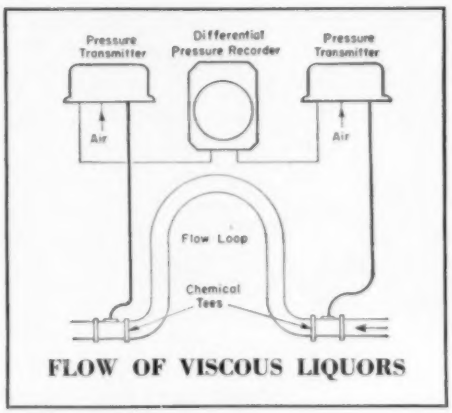
COLUMN PRESSURE

NARROW RANGE SPAN DETECTS PRESSURE TRENDS

Problem: To get highest possible purity of product consistent with good production economy. This requires the quick detection of pressure trends over a very narrow range.

Solution: The short, shiftable range spans (as short as 20 psi) of the TRANSAIRE Pressure Transmitter permit selection of operating range by a simple screwdriver adjustment. Its high order of sensitivity enables the operator to detect minute changes of pressure.

Result: Close control, because the minute pressure trends are practically instantaneously detected and transmitted to the controller and receiver. This means higher yield of a purer product, also great flexibility in changing to different product requirements.



FLOW OF VISCOUS LIQUORS

STREAMLINED SURFACE PREVENTS SCALE, SOLIDIFICATION

Problem: Flow measurement of viscous material which tends to solidify when static, making conventional differential producers impractical.

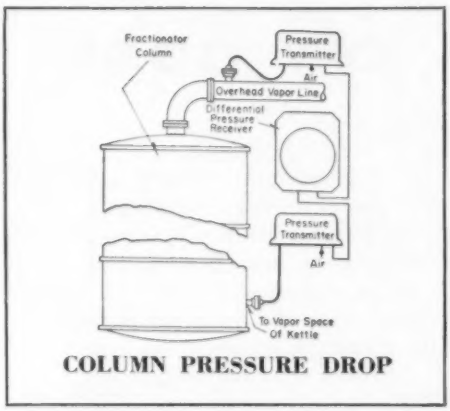
Solution: Its flush element presents a streamlined surface and tends to prevent formation of scale or solidification of liquors. Its short range, high sensitivity and volumetric construction make the TRANSAIRE Pressure Transmitter ideal for this application.

Result: Trouble-free, accurate measurement and control of flow. One installation has given continuously satisfactory service for four years.

*Reg. U.S. Pat. Off.

Typical installation of a TRANSAIRE Pressure Transmitter on a distillation column. Note close-coupled connection in field. Receiver may be several hundred feet away.

SOLVED THESE FOUR TOUGH PROBLEMS



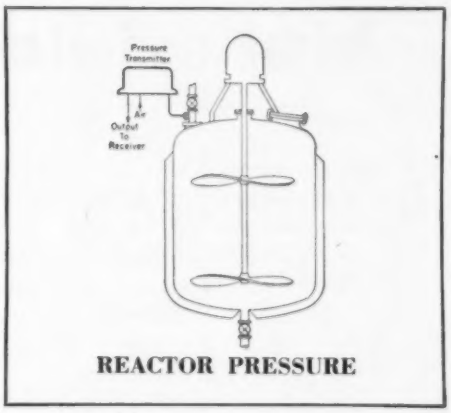
COLUMN PRESSURE DROP

PERMITS MAXIMUM CAPACITY OPERATION

Problem: To operate a column at maximum capacity, consistent with the preventing of flooding.

Solution: As the pressure drop across the column is a measure of the vapor velocity, the measurement of this drop with a short-range, highly sensitive, easily adjustable instrument enables the operator to keep the column safely close to the flooding point.

Result: Maximum production and uniform operation.



REACTOR PRESSURE

FLUSH SURFACE IS CLOG-PROOF

Problem: To measure pressure in reactor kettles containing viscous or corrosive liquids which tend to clog conventional measuring systems.

Solution: The closed volumetric measuring system of the TRANSAIRE Pressure Transmitter presents a flush surface on the inside of the vessel. It is clog-proof, highly sensitive and provides an accurate reading.

Result: Maximum yield of high purity product and a precise knowledge of the pressures maintained.

Taylor Instruments MEAN ACCURACY FIRST

CATFORMING *means*

SIMPLICITY

for high octanes and high yields at low cost

Simplicity is the keystone of Catforming. Why? Because simplicity takes the high cost out of high octanes and high yields.

Simplicity speeds construction of Atlantic Catforming units—saving you money and time.

Simplicity makes operation of these units easy—saving you money on operating costs and manpower as well.

Simplicity means efficiency — Catforming cuts out intermediate steps in processing feed stocks, gives you high octane gasoline ready for immediate blending—and distribution.

Simplicity goes all the way with Catforming, including the licensing agreement—you'll find it well worth looking into. Remember, the performance of Catforming units has been proved in highly successful commercial operations in many areas. Write, wire or phone for detailed information — ask for our brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa.

ATLANTIC *It's the Catalyst that counts*

10 years of research . . . over 75 years of pump manufacturing experience . . .

THE NEW PATENTED HILLS-McCANNAMETER

"the meter that pumps . . ."

A. POSITIVE DISPLACEMENT METERING

. . . plus

B. NO FRICTIONAL PARTS IN LIQUID END

. . . plus

C. CONTINUOUS FLOW CHARACTERISTICS

The Hills-McCannameter—"the meter that pumps"—establishes an entirely new set of standards for precision, accuracy and reliability in small volume metering and proportioning.

SPECIFICATIONS—Series "A"

Effective capacity range: 5 c.c. to 6 gal. per hr.
Standard pressure range: to 2500 psi (special designs to 10,000 psi).

If you have been looking for a pump that will *precisely* meter a wide output range of small volume flows, here is the answer. Write today. HILLS-McCANNA CO., 2448 W. Nelson St., Chicago 18, Illinois.

Check and compare with any other pump

- No stuffing boxes
- High speed, self cleansing valves
- Hydraulically balanced
- Stepless volume control
- Automatic vapor venting
- Downhill* metering

*From high suction to lower discharge pressure.

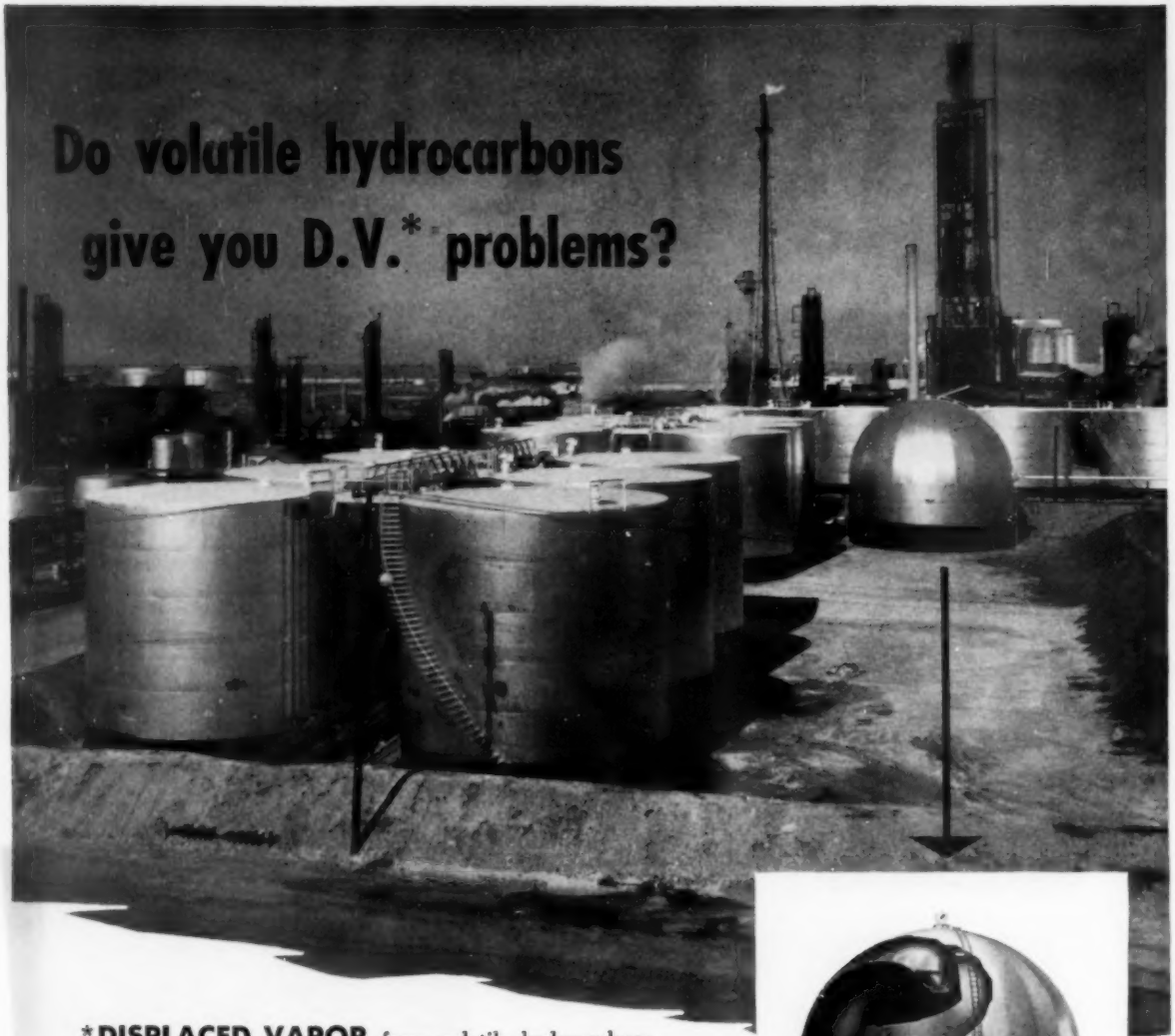
See *the Hills-McCannameter in action at the Instrument Show, Sept. 14-24. Tickets for the demonstrations can be secured at Booth 101.*

HILLS-McCANNA

metering and proportioning pumps

Also Manufacturers of

SAUNDERS PATENT DIAPHRAGM VALVES • FORCE FEED LUBRICATORS • MAGNESIUM ALLOY SAND CASTINGS



***DISPLACED VAPOR** from volatile hydrocarbons stored in fixed-roof tanks need not be vented to the atmosphere. A Horton Vaportank can save that vapor—and save you money.

The Vaportank is an independent vapor storage unit that can be interconnected to one or more fixed roof tanks by large diameter vapor piping. As the central storage unit in a vapor saving system, the Vaportank has a flexible hemispherical membrane attached to the top of its vertical shell. Vapor displaced from interconnected tanks by increasing temperature or filling is stored under the flexible membrane. As long as the capacity of the Vaportank is not exceeded, no vapor is vented to the atmosphere. When conditions causing the displacement are reversed the vapor returns to the tanks

Further information, estimates or quotations on Horton Vaportanks, or any other Horton® vapor saving structure, may be obtained by writing our nearest office. There is no obligation on your part.

Top: A 50,000-cu. ft. Horton Vaportank and some of the sixteen fixed roof tanks to which it is interconnected, at the Taylor Oil and Gas Company refinery, Corpus Christi, Texas. Above: Cutaway view of a Horton Vaportank showing the flexible membrane.

CHICAGO BRIDGE & IRON COMPANY

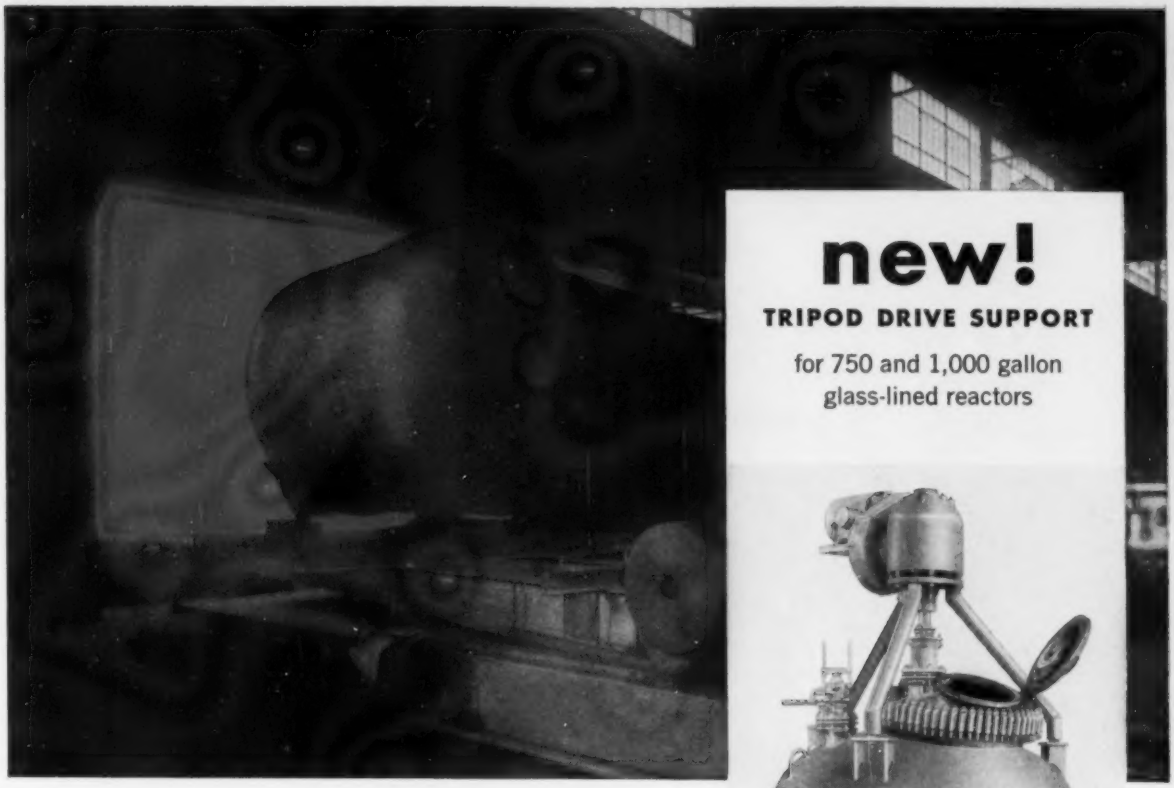
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, and GREENVILLE, PENNSYLVANIA

Atlanta 3	2103 Healey Building	Detroit 26	1532 Lafayette Building	Pittsburgh 19	3236 Alcoa Building
Birmingham 1	1527 North Fiftieth Street	Houston 2	2130 CGI Life Building	Salt Lake City 4	530 West 17th South Street
Boston 10	1029—201 Devonshire Street	Los Angeles 17	1526 General Petroleum Building	San Francisco 4	1559—200 Bush Street
Chicago 4	2114 McCormick Building	New York 6	3310—165 Broadway Building	Seattle 1	1330 Henry Building
Cleveland 15	2215 Midland Building	Philadelphia 3	1630—1700 Walnut St. Building	Tulsa 3	1620 Hunt Building

REPRESENTATIVES AND LICENSEES

Horton Steel Works Limited, Fort Erie, Ontario, Canada
Ateliers et Chantiers de la Seine Maritime, Paris, France
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela
Compagnia Tecnico Industrie Petroli, Rome, Italy
Whessoe, Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Comprimo N. V., 21, Amstel, Amsterdam (C) Netherlands

Sociedade Chibridge de Construcoes Ltda., Av. General Justo 275, Grupo 306, Rio de Janeiro, Brazil



new!

TRIPOD DRIVE SUPPORT

for 750 and 1,000 gallon glass-lined reactors

Typical of the exclusives you secure with Glascote products is this true tripod drive support. It has excellent stability because of its heavy tubular construction. It simplifies piping layout, provides better accessibility to agitator stuffing box and maximum clearance of ports . . . a plus value obtainable only from Glascote.

Glascote
PRODUCTS, INC.
An A. O. Smith subsidiary

Where glass weds steel for corrosive service

We invite you to share in the advantages which are provided in glass-on-steel processing equipment obtainable under the Glascote name. As a producer of chemicals, petro-chemicals, pharmaceuticals, plastics or synthetics, you will appreciate the superior corrosion resistance and design of Glascote reactors, receivers, condensers, evaporators, storage tanks and transport tanks.

You will find our acid-resistant . . . or acid- and alkali-resistant . . . glass, fused to the appropriate steel backing, a dependable defense against corrosive attack. It withstands both thermal and impact shock. It assures extended life for the vessel and effectively protects materials in process from metallic contamination.

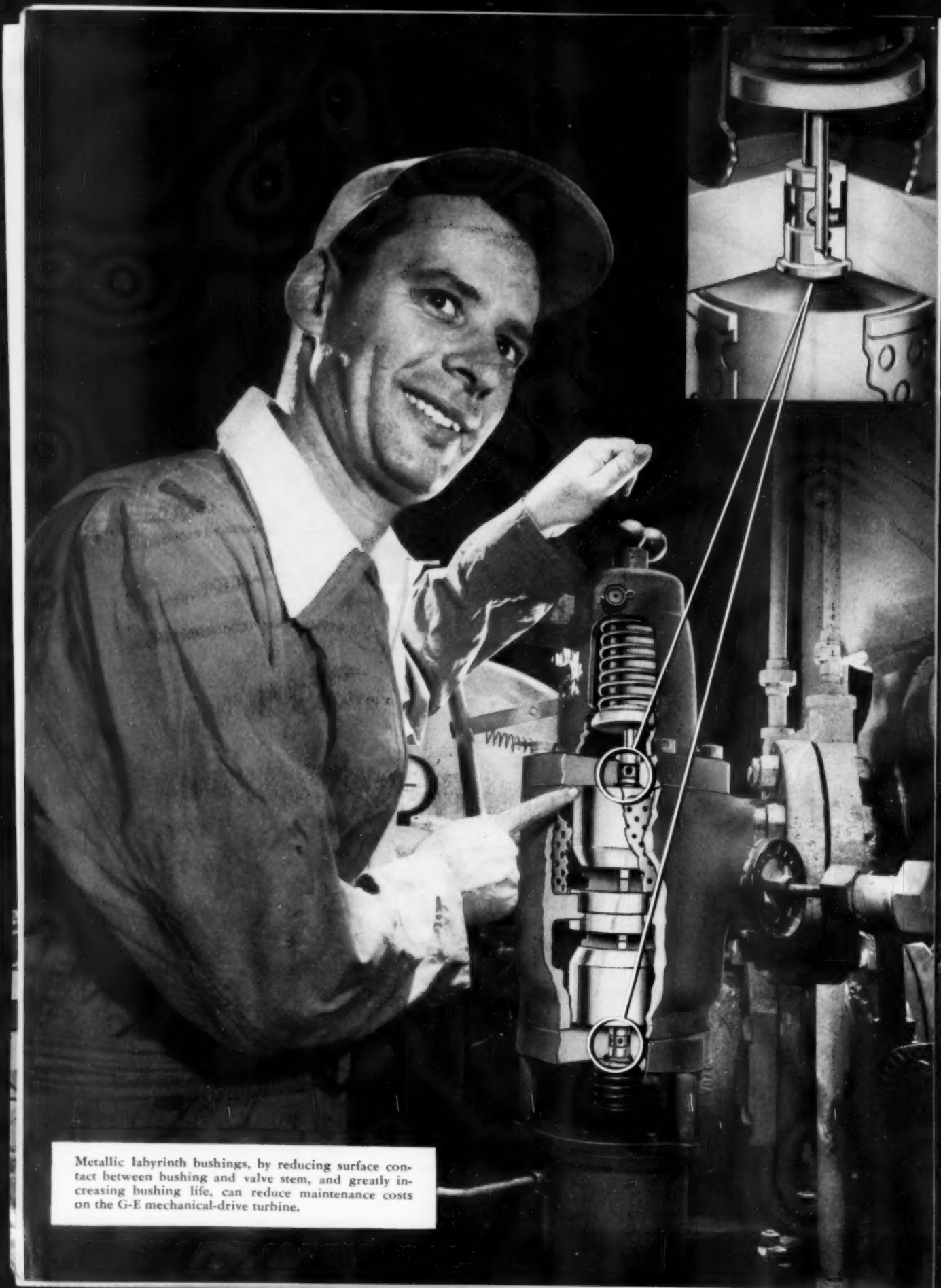
Look to Glascote for the corrosion-resistant processing equipment you need . . . in standard or custom designs.

Glascote
PRODUCTS, INC.

CLEVELAND 17, OHIO
A subsidiary of A. O. Smith Corporation

Sales offices or agents in Principal Cities
Export Sales: A. O. Smith Corporation,
International Division,
Milwaukee 1, Wisconsin

(To obtain more data on advertised products see page 1464)



Metallic labyrinth bushings, by reducing surface contact between bushing and valve stem, and greatly increasing bushing life, can reduce maintenance costs on the G-E mechanical-drive turbine.

ANOTHER PLUS VALUE OF G-E MECHANICAL-DRIVE TURBINES...

Metallic Labyrinth Bushings Cut Turbine Maintenance Costs

Using metallic labyrinth bushings instead of soft packing on the throttle valve stem and operating valve stem of General Electric's Type DP mechanical-drive turbine has several important advantages. Corrosive attacks on the valve stems, often caused by soft packings, are prevented.

Because surface contact between bushing and valve stem is reduced to a minimum, friction is practically eliminated—bushing life is increased tremendously. This feature alone can save you up to $50.00 in direct maintenance costs—plus the expense of down-time caused by frequent packing replacements.

HERE'S ANOTHER ADVANTAGE. Since frictional drag on the governing system is reduced to a minimum, you get more accurate, sensitive, reliable governing with G.E.'s Type DP turbine.

Metallic labyrinth bushings make an effective steam seal by means of grooves in the bushing which throttle pressure and minimize any steam leakage (see illustration).

THESE METALLIC LABYRINTH BUSHINGS are just one of many DP features which save you money throughout total turbine life. The chart below indicates other areas of savings.

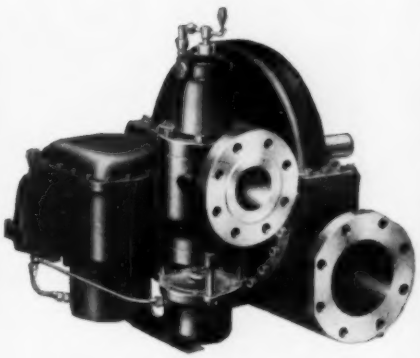
Remember—the total cost is often more than just the sales price. But G.E.'s standard DP turbines include the extra features that save you extra costs. For more information contact your nearest G-E apparatus sales office. Write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." General Electric, Schenectady 5, N.Y.

252-66

GENERAL ELECTRIC

INSTALLATION AND MAINTENANCE COST-SAVING FEATURES

THESE EXTRA FEATURES, STANDARD ON ALL G-E TYPE DP TURBINES, CAN . . .	Save You up to
COMBINED TRIP-THROTTLE VALVE Eliminate extra cost of buying and installing valve ahead of the turbine.	$200.00
SINGLE RESERVOIR FOR COOLING LUBE OIL Eliminate extra cost of piping cooling water to and between bearings.	50.00
MAJORITY OF PARTS INTERCHANGEABLE One set of spare parts protects several units—less money tied up in inventory.	100.00
METALLIC-LABYRINTH VALVE STEM BUSHING Eliminate labor costs of replacing soft packings; cut down-time production losses.	50.00
SHAFT MONEL-SPRAYED AT PACKING FIT Saves frequent cost of purchasing and installing carbon rings; contributes to long shaft and packing life.	20.00
ESTIMATED TOTAL SAVINGS	$420.00

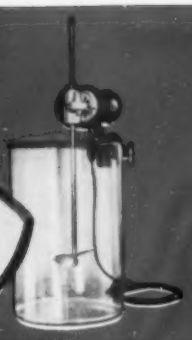


G-E Type DP Mechanical-drive Turbine

COMPARE THE FEATURES
EVALUATE ALL THE COSTS

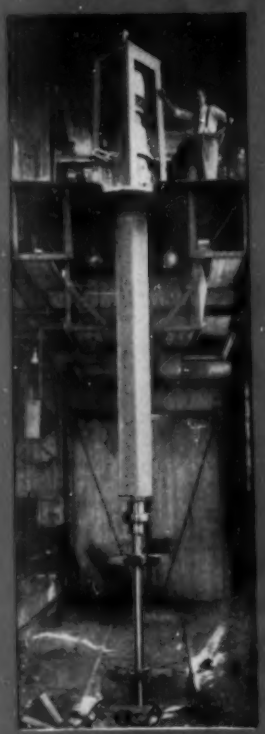
See why G-E Standard Type DP turbines are your most economical buy.

Eastern Mixers lick the Tough problems...



LABORATORY STIRRER

EASTERN INDUSTRIES ★ MIXER DIVISION ★



LARGE TOP-ENTERING TURBINE MIXER

There's an Eastern Mixer to handle every fluid mixing problem. Whatever your process is, Eastern will work out the problem to your complete satisfaction, and at moderate cost. In nearly every industry engaged in processing of liquids, Eastern engineers have repeatedly scored triumphs over troublesome and unusual problems.

Eastern Mixers come in a variety of sizes and types. From tiny laboratory stirrers weighing less than a pound, to giant turbine mixers, Eastern equipment runs the gamut of needs for all-size mixing jobs.

Variable speed laboratory STIRRERS are constructed for hard, continuous usage. PORTABLE MIXERS are available with large variety of choices in styles, horsepower, motors, and mounting arrangements. TOP AND SIDE ENTERING MIXERS with fixed-mounting take care of the big jobs. Both propeller and turbine type units are available in a large variety of sizes and ratings.

When anticipating the purchase of fluid mixing equipment, send for Eastern Data Sheets. Our engineering staff will specify the most efficient units complying with the data of your particular problem.

Request 4 helpful catalogs by writing for Catalog Series 16.

PORTABLE MIXER

EASTERN INDUSTRIES ★ MIXER DIVISION ★

SIDE-ENTERING MIXER

Eastern

INDUSTRIES, INC.

REGENT STREET

EAST NORWALK, CONN.

When it's a question of caustic corrosion

...Refiners find Monel effective

Wherever caustic soda is used in petroleum refining, it is apt to create a corrosion problem. Some of the most troublesome occur in:

1. Caustic regeneration in mercaptan removal processes.
2. Lube oil and wax treatment.

In both processes, Monel is widely used for equipment that must stand up under corrosion by hot caustic solutions.

In caustic regeneration, you find Monel used for the regenerating towers, for pumps, piping, preheaters and reboilers. For parts where temperatures may reach or exceed 500°F., as in evaporator tubes, Inconel is to be preferred for its superior resistance to sulfide-containing caustics.

In the large outdoor agitators where hot wax is allowed to settle, then washed free of excess caustic left after neutralization processes, Monel linings have proven to be a satisfactory solution to the corrosion problem. Both nickel and Monel equipment are used to store caustic solutions. "S" Monel, with its excellent anti-galling properties is combined with Monel in hard-to-lubricate pumps to prevent seizing.

Why Monel?

Two tests show how effective Monel is in equipment where hot caustic solutions are handled.

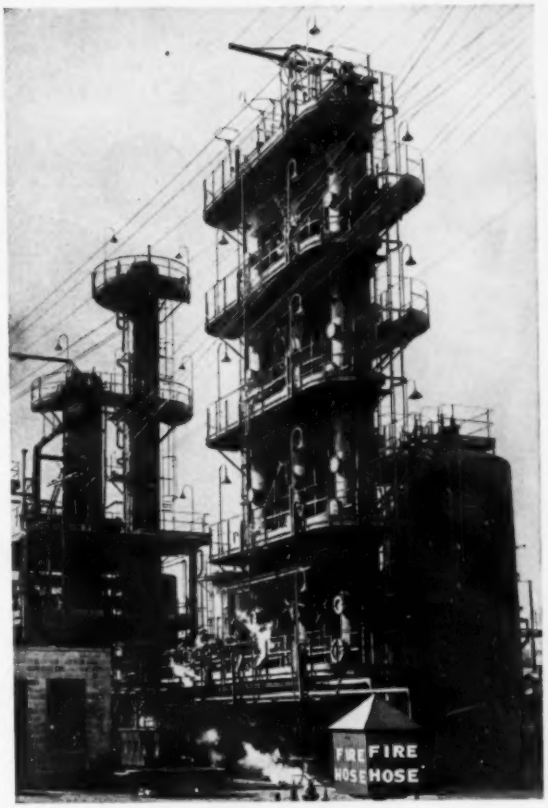
Test A — **Reboiler of Caustic Soda Regenerator**

Material	Corrosion rate, in. per yr.	Conditions
Inconel	0.0001	Solution contained 1-2% sodium hydroxide, 3% sodium phenolate, 0.07 mg/100 cc sodium mercaptides. Temp. 225°F.; Duration, 131 days.
Monel	0.001	
Next Best	0.017	

Test B — **Vapor Section of Caustic Soda Regenerator**

Material	Corrosion rate, in. per yr.	Conditions
Inconel	0.0003	Solution contained 13.2% sodium hydroxide, 0.37% sulfide sulfur, 0.80% mercaptide sulfur. Temp. 300° (Av.); Duration, 55 days.
Monel	0.002	
Nickel	0.002	
Next Best	0.013	

Have you a caustic soda corrosion (or purity) problem?
Then get in touch with Inco's Corrosion Engineering Section. Write: International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.



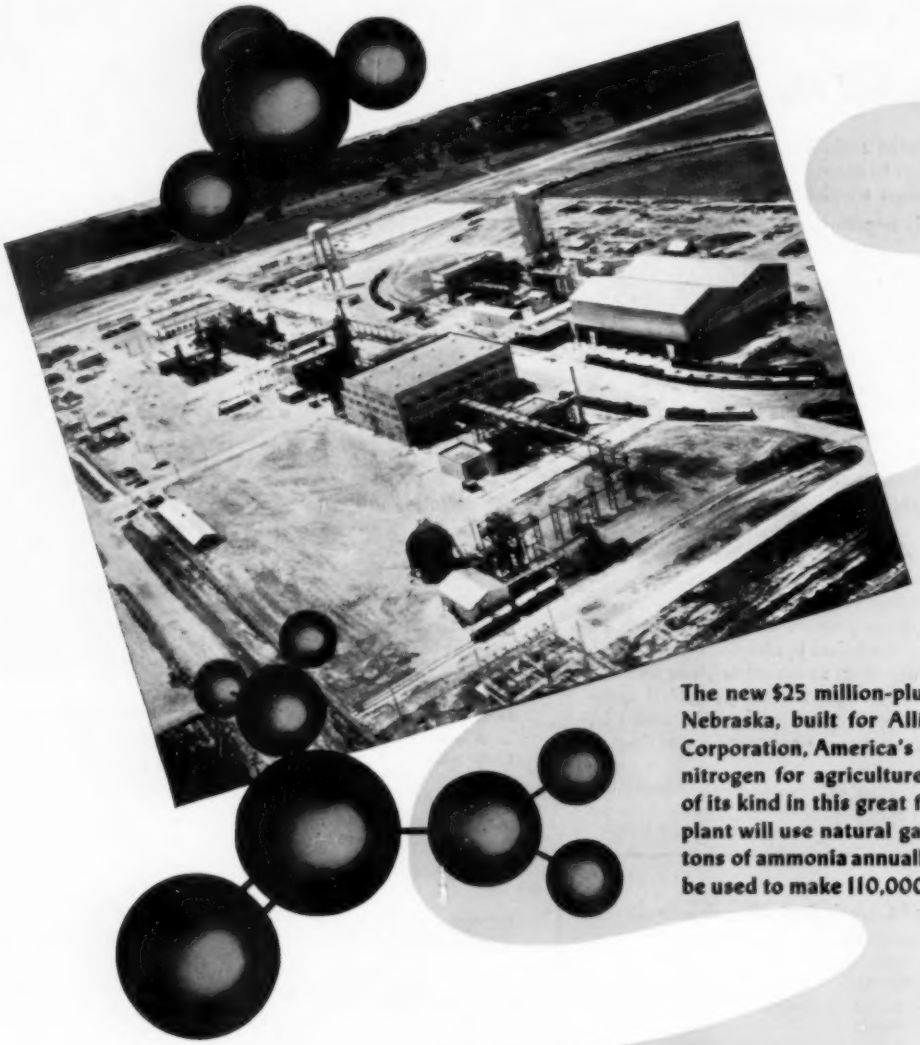
Regenerator Tower in Unisol* Process Installation at Atlantic Refining Company's Philadelphia refinery. In this tower mercaptan-contaminated methanol-caustic soda solution is regenerated by stripping with steam. Its solid Monel construction protects the tower from the extreme corrosiveness of the hot solution. Piping, pre-heater, and reboiler are also Monel.
*Licensed by Universal Oil Products, Chicago.

Agitator Tanks for Wax Washing, also at Atlantic's Philadelphia refinery. After neutralization by caustic and subsequent settling, wax is washed free of excess caustic with hot water in these tanks. Coned bottoms and sides to a height of 6 ft. are lined with Monel to withstand corrosion by hot caustics.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street — New York 5, N. Y.

Monel... for minimum maintenance

Inco Nickel Alloys



The new $25 million-plus plant at La Platte, Nebraska, built for Allied Chemical & Dye Corporation, America's leading producer of nitrogen for agriculture and industry. First of its kind in this great feed-producing area, plant will use natural gas to produce 75,000 tons of ammonia annually, most of which will be used to make 110,000 tons of urea a year.

CATALYTIC ON-TIME...ON-BUDGET SERVICES

for the chemical, petrochemical and oil refining industries • Project Analysis • Process Design • Economic Studies • Engineering • Procurement • Construction • Plant Operation

"THANK YOU, CATALYTIC,

For a big job done on time and well."

We at Catalytic are proud of our performance in this major construction facility. Catalytic's on-time, on-budget record in the fields it serves is a highly regarded asset. It permits clients to plan closely on production and sales—on which, of course, profit expectations can be based.

Nitrogen Division
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET
NEW YORK 6, N. Y.

OFFICE OF THE PRESIDENT

June 23, 1954

Mr. T. Ellwood Webster, President
Catalytic Construction Company
1528 Walnut Street
Philadelphia 2, Pa.

Dear Mr. Webster:

Congratulations on your completion of the ammonia-urea plant you built for us at Omaha, Nebraska, well ahead of the time schedule and comfortably within our cost estimates. It was a big, complicated job, involving some of our new process developments never before incorporated in a commercial plant. Few craftsmen were available familiar with the type of construction required, which was new to the Omaha area. In spite of these and other difficulties, it was altogether a fine performance and your organization is entitled to commendation for it.

Best personal regards.

Sincerely yours,

Hugo Riemer
President

CATALYTIC
CONSTRUCTION COMPANY

1528 Walnut Street, Philadelphia 2, Pennsylvania

In Canada: Catalytic Construction of Canada, Limited: Sarnia, Ontario

An unbeatable team for temperature measurement

DYNALOG RECORDERS and DYNATHERM BULBS

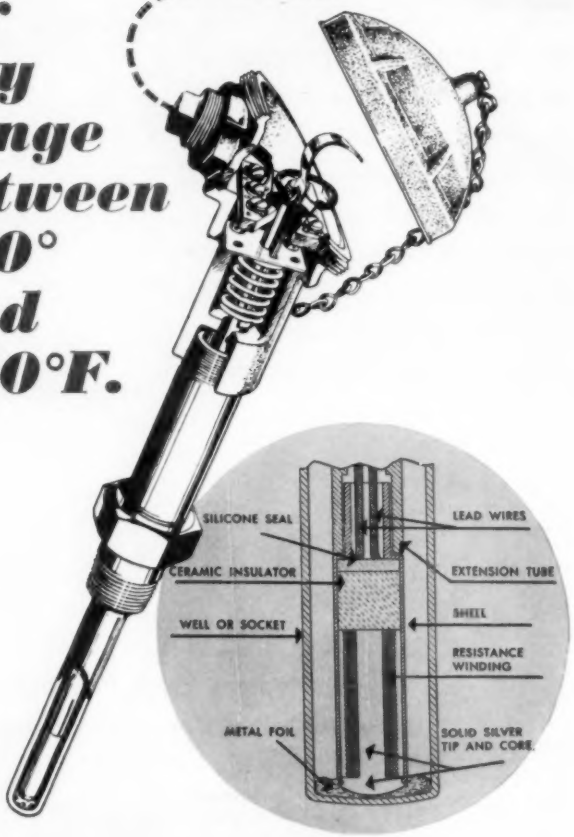
You can't beat this Foxboro Dynalog-Dynatherm combination for insuring better temperature measurement on any job between–100° and+600°F. It gives you every advantage of speed, accuracy, long leads, simple installation, economy, and freedom from maintenance. This is why:

The Dynalog Electronic Recorder has an exclusive variable-capacitor measuring system which eliminates slidewires, gears, cables, high speed balancing motors . . . no dead space, no batteries to standardize, no motors to service. Standard full-scale pen speed only 3 seconds. Sustained accuracy ¼ of 1% guaranteed. Available for spans as narrow as 5°F. with full-accuracy calibration.

The Dynatherm Resistance Bulb has unique features including metal-to-metal end-contact which, when installed in a well or socket, gives a speed of response unsurpassed by any other similarly protected temperature-sensitive element. Exceptionally rugged and permanent in calibration.

These are only a few of the important advantages of this better temperature measuring system . . . available also for control of temperatures, or with Multi-Record Dynalog Recorder for up-to-6 records on one chart. Write for illustrated bulletins, The Foxboro Company, 919 Neponset Ave., Foxboro, Mass., U.S.A.

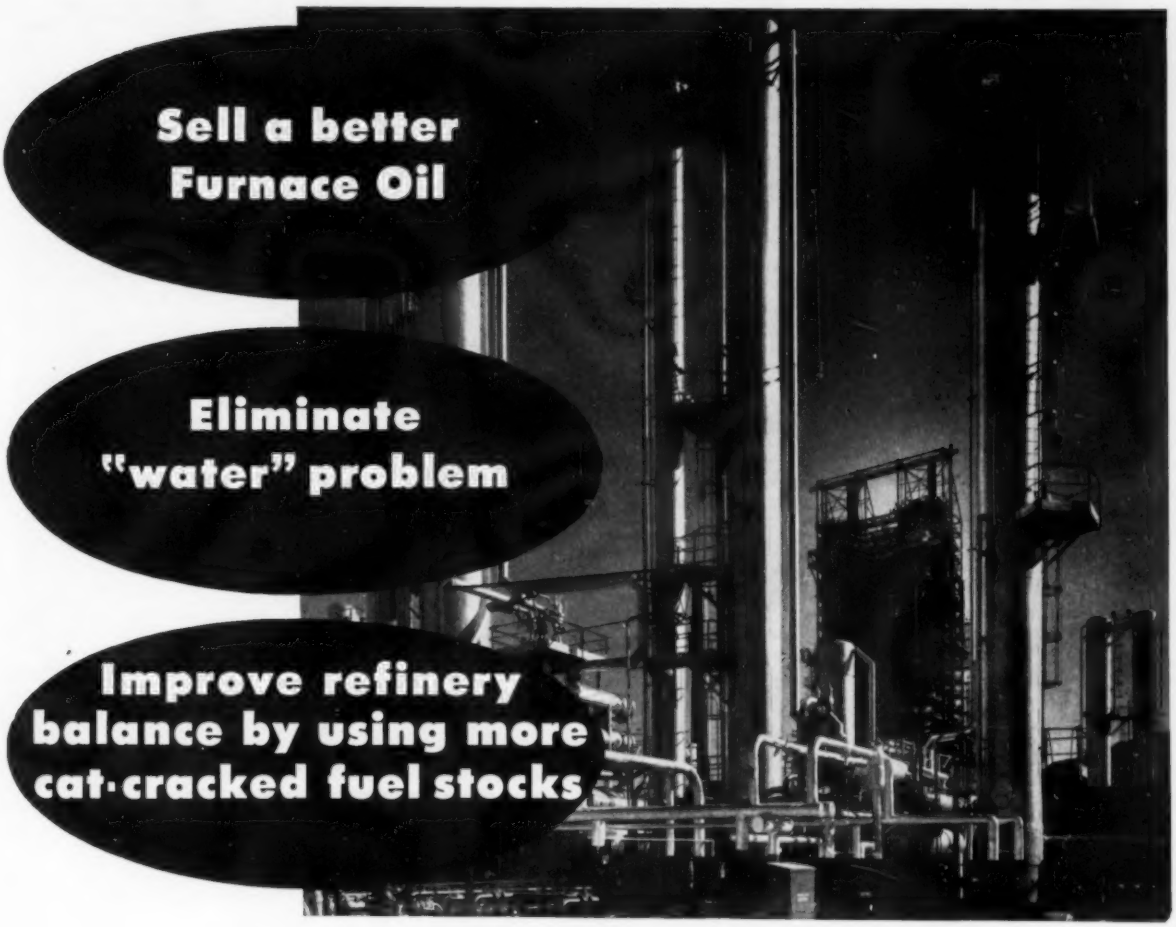
for any range between -100° and +600°F.



FOXBORO REG U S PAT OFF **INSTRUMENTATION**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

With NEW Dispersant FO



Dispersant FO is a new gum-dispersing, rust-inhibiting additive that greatly reduces, even eliminates, deposits and screen clogging in home heating units and storage tanks. Your product with FO will offer dealers many competitive advantages and greatly reduce their number of costly service calls due to clogged filter screens and nozzles.

"Wet fuel" is always *the big problem* for the distributor, dealer and home user. The active ingredient in FO is an entirely new chemical, developed especially for use in furnace oils. NEW DISPERSANT FO DOES NOT EMULSIFY WATER WITH BURNER OIL. It will settle the water out of burner oils in short order to provide a "dry" fuel.

Furnace oil with FO has exceptional rust-proofing properties. Steel and iron surfaces in contact with the oil and the water layer are made corrosion resistant.

This new additive improves stability and permits the blending of higher percentages of cat-cracked stocks without additional gum formation. It improves refinery balance, and you can cut costs by reducing the severity of acid treating of your cat-cracked heating stocks.

The stabilizing action and rust-inhibiting quality of Dispersant FO are obtained at very low dosages. Usually added in the ratio of 1 pint per 1000 gallons of oil stock, at any temperature, prior to shipment by tanker, pipe line or truck.

For complete product data and samples, write or phone the nearest Oronite office.

ORONITE CHEMICAL COMPANY

200 Bush St., San Francisco 20, Calif. • 714 W. Olympic Blvd., Los Angeles 15, Calif.
30 Rockefeller Plaza, New York 20, N.Y. • 20 North Wacker Drive, Chicago 6, Ill.
Mercantile Securities Building, Dallas 1, Texas

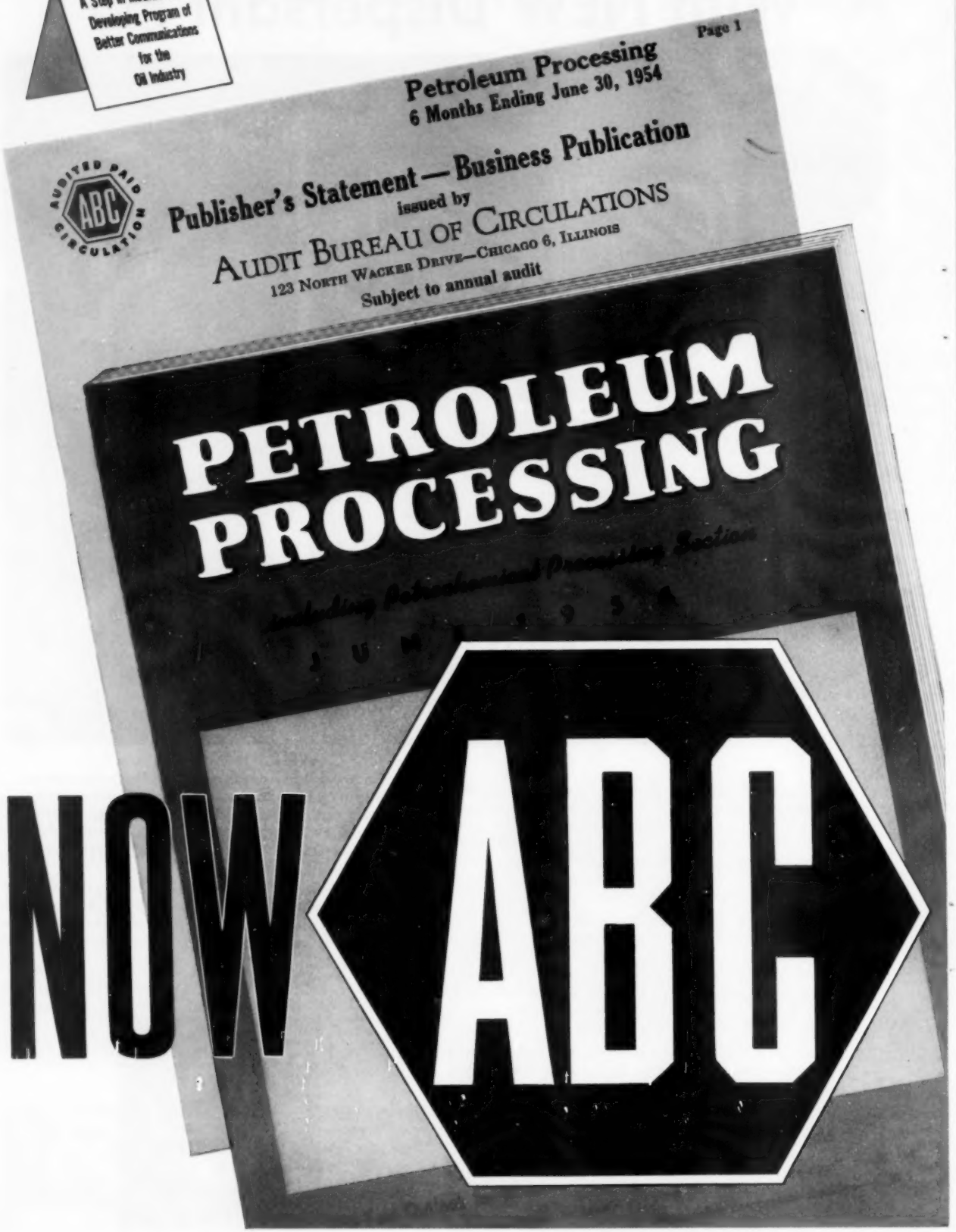
ORONITE CHEMICAL COMPANY

2631

 (To obtain more data on advertised products see page 1464)

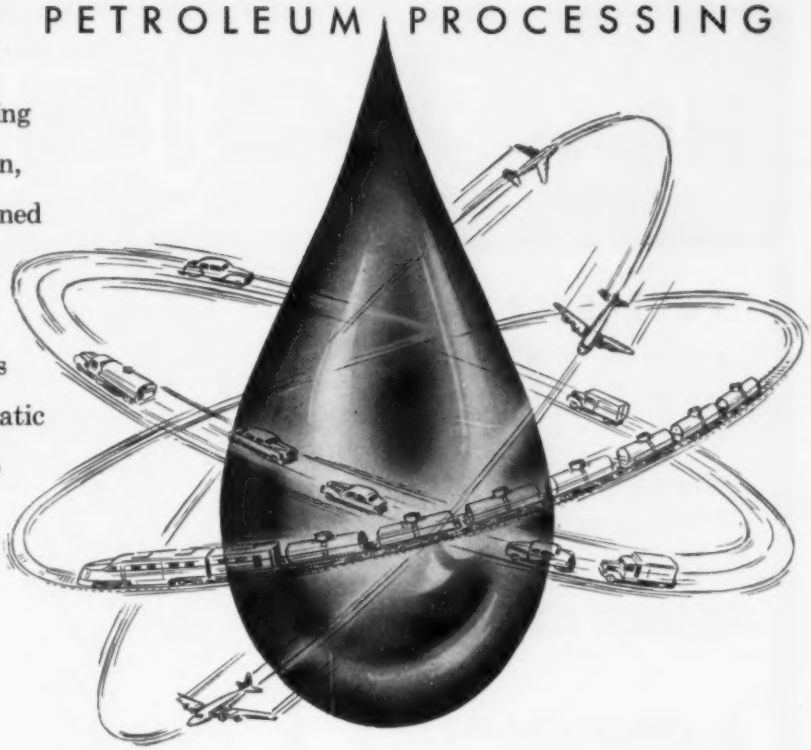
LOOK INTO THE FUTURE . . . .

A Step in McGraw-Hill's Developing Program of Better Communications for the Oil Industry



. . . LOOK INTO PETROLEUM PROCESSING

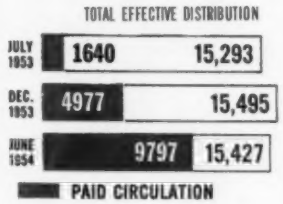
Scarcely a year after beginning conversion to paid circulation, *Petroleum Processing* has earned Audit Bureau of Circulation membership . . . tangible evidence of this publication's importance to readers, dramatic proof of its growing value to advertisers!



The Magazine . . .

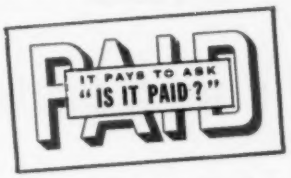
Petroleum Processing delivers intensive readership throughout all aspects of petroleum processing, with the largest coverage in this expanding field. If you sell equipment, components, supplies or materials used in petroleum and petrochemical processing—you can reach all phases of this fast growing market with *Petroleum Processing*.

The Readers . . .



This rapid conversion to paid circulation has been accompanied by substantial increases in readership scores in reader traffic studies. For the past five years *Petroleum Processing* has shown steady gains in independent reader preference surveys.

The Meaning . . .



Refinery and Petrochemical Engineering and maintenance staffs, process engineers, research and development men rely on *Petroleum Processing* to keep abreast of technological news. Their growing *paid* subscriptions testify to reader interest . . . guarantee circulation quality . . . assure continuing editorial vitality.

PETROLEUM PROCESSING

NOW A McGRAW-HILL PUBLICATION

330 WEST 42nd STREET, NEW YORK 36, N. Y.

ABP ABC

TRET-O-LITE

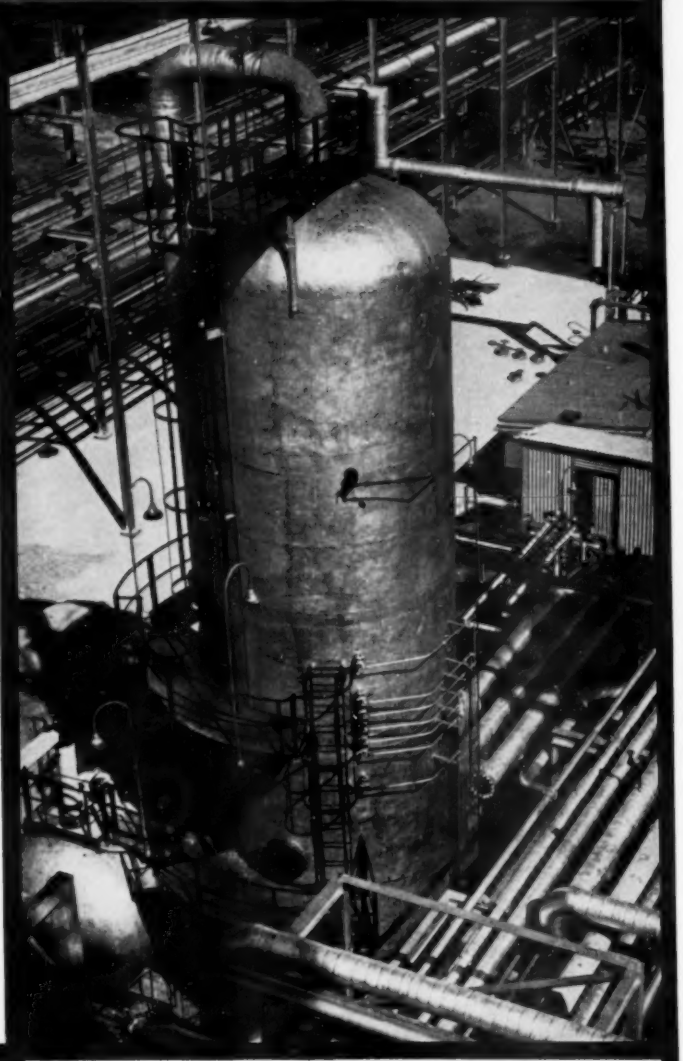
YOUR BEST BUY IN

DESALTING

Here are
5 reasons why

1. LOWEST PLANT COST
2. LOWEST OPERATING COSTS
3. SIMPLICITY
4. EASE OF OPERATION
5. MAXIMUM EFFICIENCY

Your Tretolite desalting engineer will gladly provide facts and figures to substantiate these statements. Why not get in touch with him?



TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Ave., Saint Louis 19, Missouri

5515 Telegraph Road, Los Angeles 22, Calif.

Chemicals and Services
for the Petroleum Industry

DESALTING • CORROSION PREVENTING • SCALE PREVENTING
DEMULSIFYING • WATER DE-OILING • PARAFFIN REMOVING

TD 54-21

NEW speed...accuracy...dependability...

in the measurement of percentage hydrogen

in liquid hydrocarbons

THE NEW cenco® BETA RAY H/C METER

utilizes radioisotopes

Here is a practical, efficient precision instrument designed for use in research as well as in product control and routine analysis. It provides a fast, accurate means of measuring the percentage of hydrogen, or the hydrogen-carbon ratio, in liquid hydrocarbons.

- ★ Makes complete determination in 5 minutes
- ★ Accurate to within 0.02 weight percent hydrogen
- ★ Handles hydrocarbons ranging from normal pentane to 1.6-dimethylnaphthalene with no change in precision over the full range
- ★ Calibration is independent of pressure changes in ionization chambers since they share a common supply of gas
- ★ Temperature changes do not affect measurement since both specific gravity and beta absorption measurements are made automatically at same temperature
- ★ Twin beam instrument using single beta ray source is independent of source variations
- ★ Adequate shielding makes instrument safe from radiation hazards
- ★ Null-point balance is independent of electrometer variations

The New Cenco Beta Ray H/C Meter fills a long felt need in numerous petroleum processing operations . . . where the hydrogen-carbon ratio is altered . . . where the percentage of hydrogen is an index to the performance of end products such as jet fuels, fuel oils, gasolines, etc. Our Bulletin No. 115 contains full details about this precision instrument. Write for your copy today.

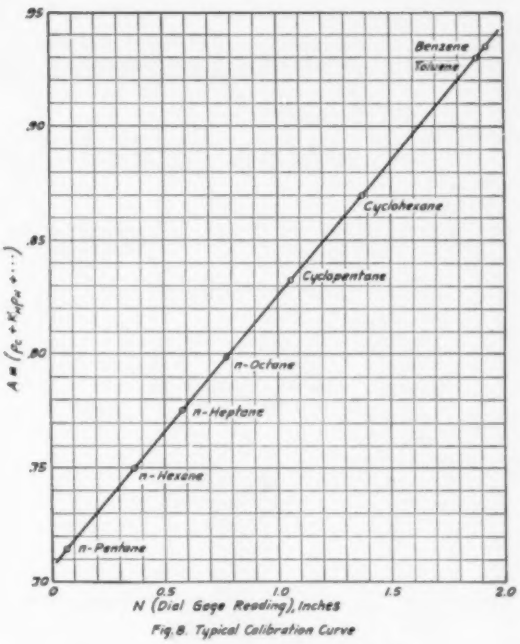


Fig. 8. Typical Calibration Curve

Exclusive manufacturing and sales rights for the Cenco Beta Ray H/C Meter have been assigned to Central Scientific Company by Standard Oil Company (Indiana).

cenco

The most complete line of scientific instruments and laboratory supplies in the world

R.S.G

CENTRAL SCIENTIFIC COMPANY

MAIN OFFICE — PLANT — CENCO INTERNATIONAL CIA.
1700 IRVING PARK ROAD • CHICAGO 13, ILLINOIS

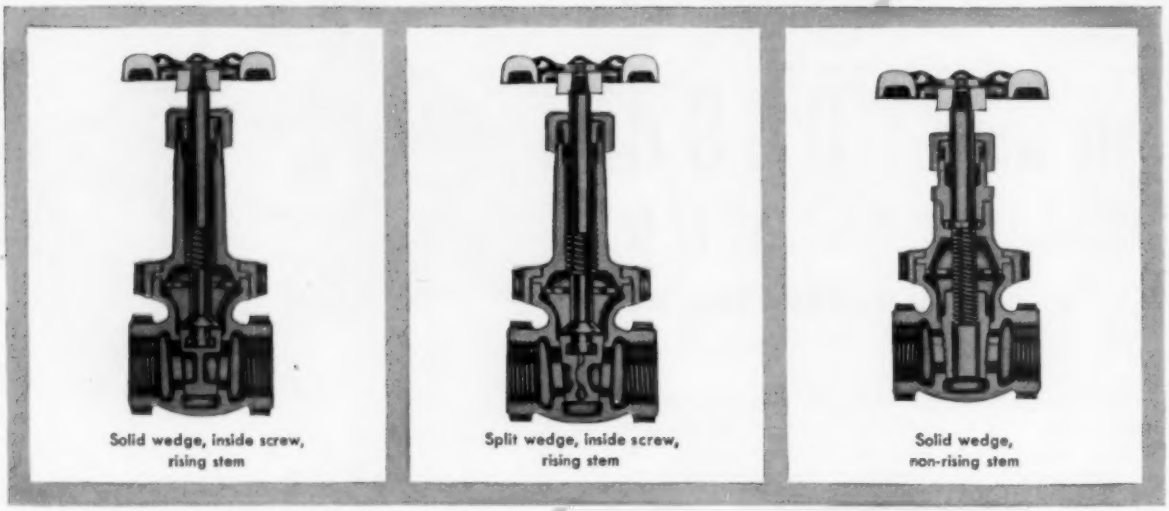
BRANCHES AND OFFICES — CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO SANTA CLARA LOS ANGELES

CENTRAL SCIENTIFIC CO. OF CANADA, LTD. (and Hendry Division)
TORONTO MONTREAL VANCOUVER OTTAWA

REFINERY SUPPLY COMPANY — TULSA HOUSTON

(To obtain more data on advertised products see page 1464)

Oh, I see



Solid wedge, inside screw, rising stem

Split wedge, inside screw, rising stem

Solid wedge, non-rising stem

. . . we've added 125 and 150 lb. bronze gate valves to our union bonnet line

WORKING PRESSURES
125 lb. W. S. P. 400° F.
150 lb. W. S. P. 400° F.

Success of our 200 lb. line of union bonnet bronze gate valves necessitates expansion of the line to include 125 lb. and 150 lb. classes. Sizes range from ¼ to 2 inches.

NOTE THESE ENGINEERING FEATURES:

This line has a flat seat on the bonnet which mates against the body, providing adequate bearing area for sealing.

Tight bonnet joint, but easy access to interior for inspection and service.

Full ports permit unobstructed flow.

Back-seating arrangement permits repacking while under pressure.

Split wedge has ball in socket contact . . . permits wedge to adjust itself to seat.

Slip-on type "T" head stem-to-wedge connection.

Lug-type hexes make valves compact and provide a better wrench-gripping surface.

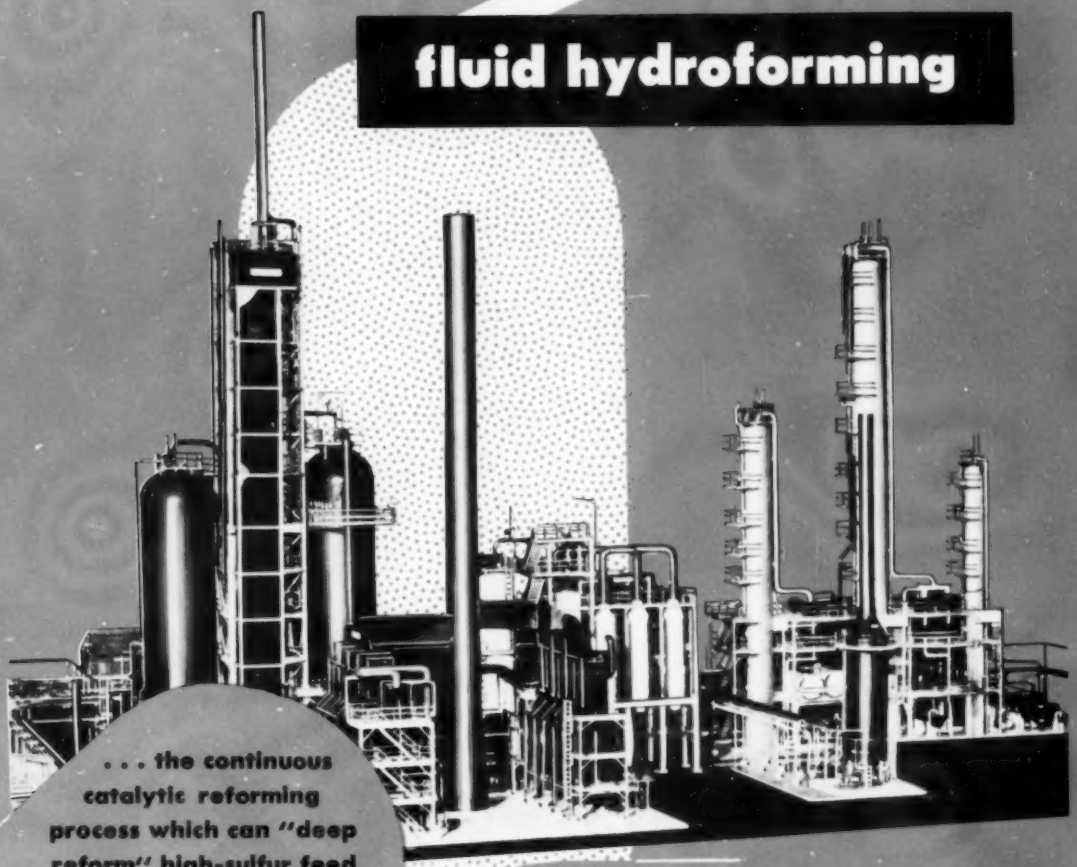
To learn more about this expanding line of valves, write for our *Union Bonnet Bronze Gate Valve Catalog Folder.*

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC
FOUNDED 1883

VALVES | **FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON**

fluid hydroforming



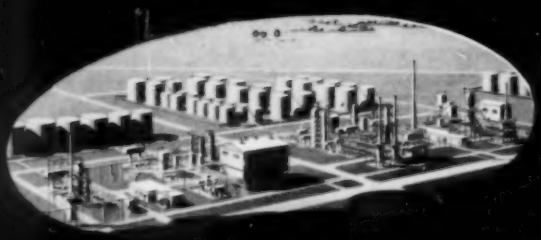
. . . the continuous catalytic reforming process which can "deep reform" high-sulfur feed stocks without rapid catalyst deterioration.

Now, the model . . . and in early 1955 . . . the completed plant:—the Fluid Hydroformer now being built by Foster Wheeler for the Creole Petroleum Corporation.

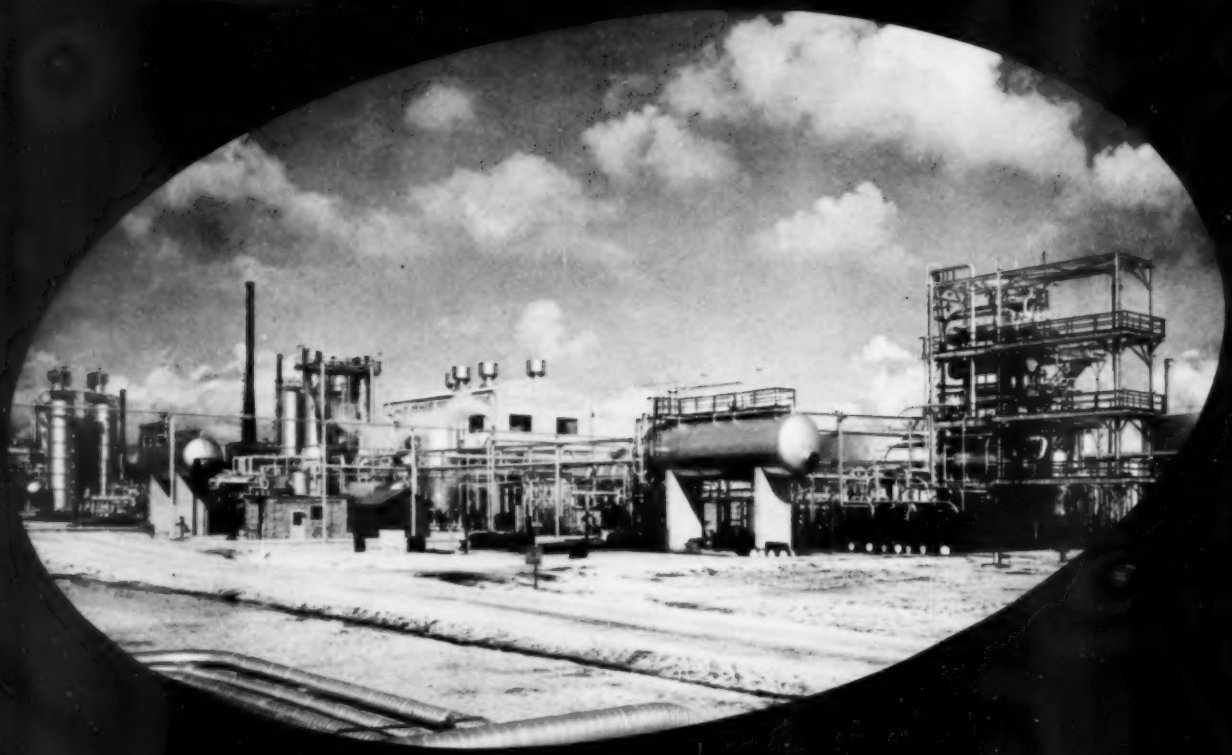
This Fluid Hydroformer is part of an expansion program at "Creole's" Amuay Bay, Venezuela refinery for which Foster Wheeler is the main contractor; also included are a 75,000 bbl/day Crude Distillation unit, a Naphtha Fractionation-Stabilization unit and extensive offsite facilities.

FOSTER WHEELER

165 Broadway,
New York 6, N. Y.



modern design
and its
realization



the Fawley lube plant

Designed and constructed by Foster Wheeler, in collaboration with the engineering department of the Standard Oil Development Company, this plant, comprising Propane Deasphalting and Dewaxing, Phenol Solvent Refining and Clay Contact Rerun units, is daily turning out superior lubes for British industry.

FOSTER WHEELER

RELIABLE PERFORMANCE at high TEMPERATURE

Cylinder-Operated
by Remote Control

- CATALYTIC CRACKING
- FLUID HYDROFORMING

Wedgeplug Valves have an enviable record for handling extremely hot oils—hot catalysts—hot gases —and hot slurry.

Wedgeplug Valves made of Carbon Steel are recommended for temperatures up to 1000° F. When special metals are used, up to 1500° F.

The tapered plug lifts, turns, and re-seats in one operation. The raised seats are protected in both the open and closed position.

WEDGEPLUG
STEEL DRY PLUG VALVES

Opening and closing time of the remote control, cylinder-operated valve illustrated can be adjusted to suit varied service conditions.

Can be supplied: wrench-operated; handwheel-operated; worm gear-operated. Adapted for remote control thru use of electric, air motor, or air cylinder operator.

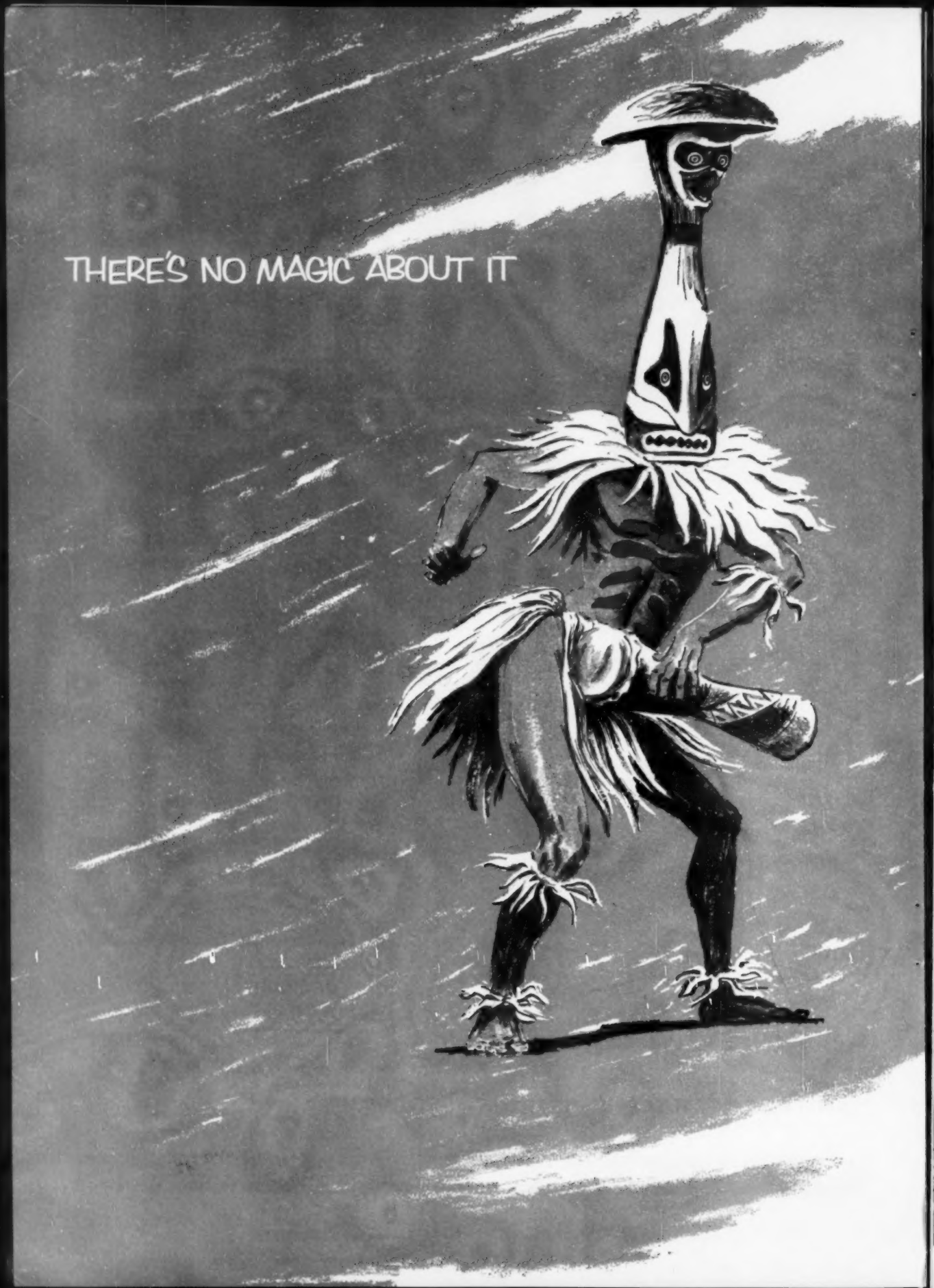
WEDGEPLUG VALVE COMPANY, INC.
NEW ORLEANS 15, LA.

An Affiliate of

STOCKHAM VALVES & FITTINGS
GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

Warehouse Stocks and
Sales Services
Strategically Located

DESIGN ELIMINATES NEED FOR LUBRICATION


THERE'S NO MAGIC ABOUT IT

. . . NOR IS THERE ANY MAGIC in saving time on even the most complicated process construction job when it's in the hands of qualified men . . . Procon men.

Saving time is the logical result of a combination of factors . . . careful planning at the outset . . . engineering competence . . . broad experience that insures quick decisions, and right ones . . . proper coordination of all duties . . . a thorough knowledge and understanding of every operation involved . . . a willing acceptance of responsibilities . . . plus a sincere desire to make every hour productive to the fullest extent.

These are Procon's standards, and while the time saved will be of great value to you, it will cost you nothing extra . . . another important reason for entrusting your next process construction job to Procon.

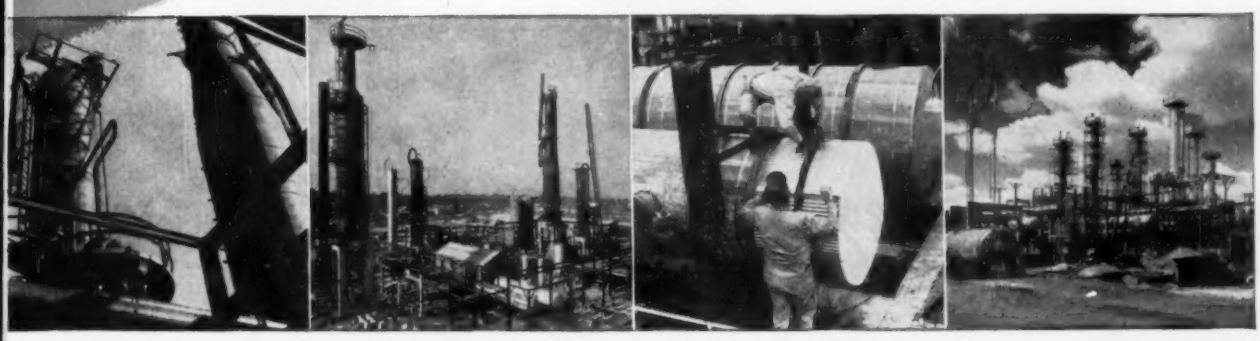
PROCON *Incorporated*

PROCESS CONSTRUCTION

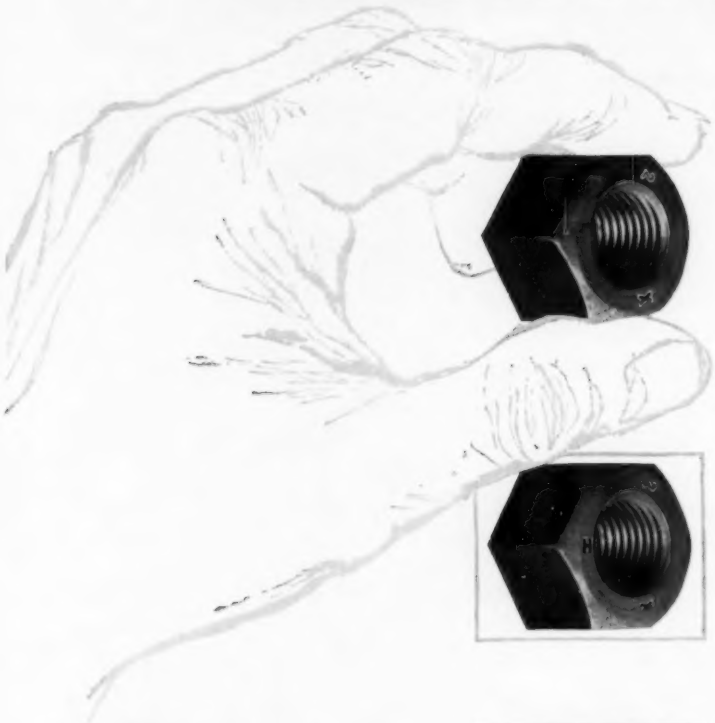
1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

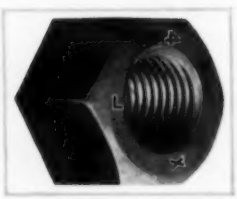
IN CANADA | PROCON (CANADA) LIMITED
40 ADVANCE ROAD
TORONTO 18, ONTARIO

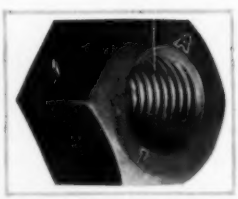
IN ENGLAND | PROCON (GREAT BRITAIN) LIMITED
112 STRAND, LONDON, W. C. 2



We make 4 types of nuts to ASTM A-194







To enable refinery engineers to choose from a well-rounded line of nuts for high-temperature, high-pressure bolting, Bethlehem produces four grades of hexagonal nuts meeting ASTM Spec. A-194. These high-quality nuts are tapped to Class 2 fit, and are made in sizes from ⅜ in. to 2 in.

For additional information about any of these nuts, or the carbon or alloy studs with which they are used, drop a line to the nearest Bethlehem sales office.

Grade 2

A medium-carbon steel nut, intended for use where temperatures and pressures are moderate. Carbon 0.40 min, Phosphorous 0.05 max, Sulphur 0.05 max. Brinell hardness 160 min. Carried in stock.

Grade 2H

A quenched and tempered nut, ideal for conditions involving high temperatures and pressures. Carbon 0.40 min, Phosphorous 0.05 max, Sulphur 0.05 max. Brinell hardness 248 to 352. Carried in stock.

Grade 4

A heat-treated molybdenum steel nut, ideal for extremely severe temperature and pressure conditions. Also suitable for sub-zero temperatures, as it has a minimum Charpy impact value of 15 ft-lb down to –150 F. Carbon 0.40 to 0.50, Manganese 0.50 to 0.95, Phosphorous 0.04 max, Sulphur 0.05 max, Silicon 0.15 min, Molybdenum 0.20 min. Brinell hardness 248 to 352.

Grade 1

A low-carbon steel nut suitable for non-critical applications. Can also be used in installations involving moderately elevated temperatures. Carbon 0.15 min, Phosphorous 0.05 max, Sulphur 0.05 max. Brinell hardness 120 min. Carried in stock.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Bethlehem supplies every type of Fastener

HERE'S HOW ONE REFINER SAVED WITH A LJUNGSTROM

COMPARATIVE FUEL AND POWER COSTS

	WITH AIR HEATER	WITHOUT AIR HEATER
Heat absorption /hr millions of BTU	100	100
Oil—inlet temp.—°F	700	700
Flue gas temp. to stack—°F	400	950
CO_2 to stack—%	10.0	11.0
O_2 to stack—%	5.2	3.7
EFF (assuming 5% radiation loss)—%	78.5	66.0
Millions of BTU required/hr	127.39	151.52
Annual cost of fuel ($2.50/Bbl—8000 hrs)	$392,000	$466,200
Kilowatt-hours	80	
Annual cost of energy @ 1¢/kwh—8000 hrs	$6,400	
Annual operating cost—fuel and energy—8000 hrs	$398,400	$466,200
Annual fuel savings	$74,200	
Annual net savings in operating costs *(fuel savings less energy costs)*	$67,800	

Wherever you burn fuel, you need LJUNGSTROM

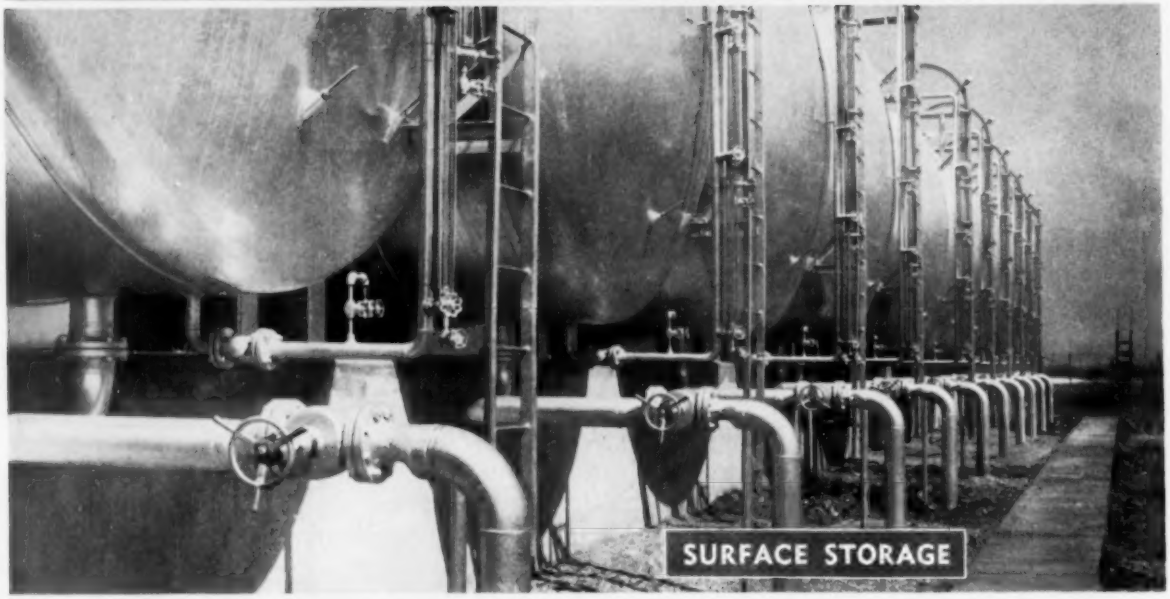
Listed in this table are comparative fuel and power costs for operating two identical deFlorez stills, one with and one without a Ljungstrom® Air Preheater. Operating costs *without* the Ljungstrom reflect performance with a convection bank of tubes.

Remember: the initial cost of a Ljungstrom installation often is more than offset by the savings reflected in eliminating the convection bank.

Remember, too — operating savings are only part of the story. Higher flame temperatures developed through the use of preheat increases heat transfer to oil tubes — thereby increasing throughput.

The Air Preheater Corporation 60 East 42nd St., New York 17, N. Y.

Hold Hydrocarbons.....



BRANCHES

HOUSTON, TEXAS
407 Velasco
(Serving the Gulf Coast)

ODESSA, TEXAS
402 West County Road
(Serving West Texas)

CASPER, WYOMING
247 West First Street
(Serving the Rocky Mountain States and Canada)

Stop product loss and product contamination by using **ORBIT FORGED STEEL LP GAS VALVES** in your plants, storage and loading facilities. You can reduce maintenance cost too, because **ORBIT FORGED STEEL VALVES** do not require a lubricant to effect a shut off. ORBIT'S friction free seating means longer service and fewer repair bills.

They are rising stem type and are so designed to require a minimum of turns to open or close. There is no guessing — a quick glance tells you if they are open or closed. There are no voids or cavities in the body of an **ORBIT LP GAS VALVE** to trap fluids. When the valve is closed it drains clean to either side of the line.

The next time you replace a valve in your operations — replace it with an **ORBIT VALVE.**

There is Only One ORBIT VALVE

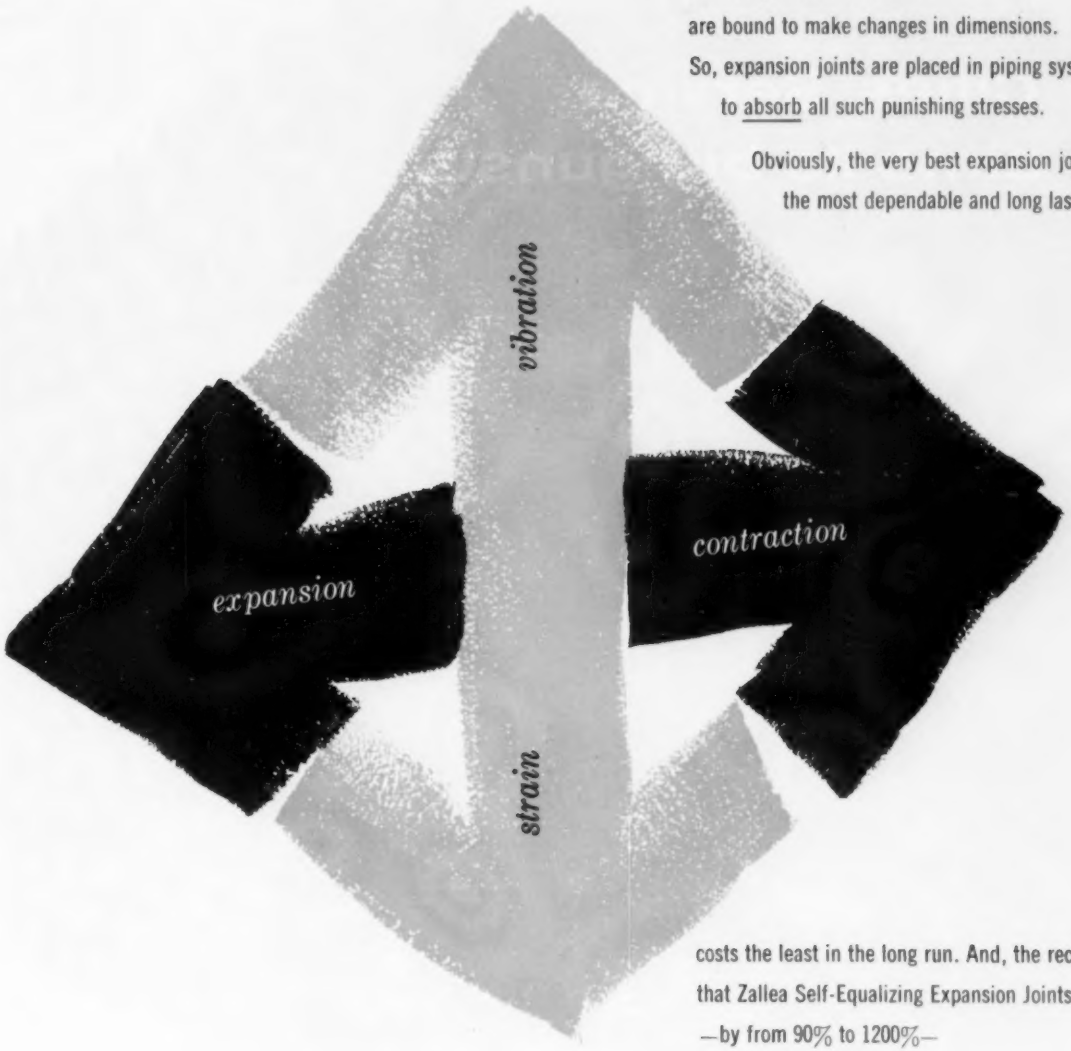
ORBIT VALVES ®

ORBIT VALVE COMPANY

P. O. BOX 699 **TULSA, OKLAHOMA**

Piping in power, petroleum and processing plants
is designed to move.
After all, service variations
are bound to make changes in dimensions.
So, expansion joints are placed in piping systems . . .
to absorb all such punishing stresses.

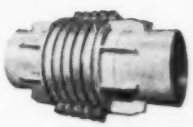
Obviously, the very best expansion joint,
the most dependable and long lasting,



costs the least in the long run. And, the records show
that Zallea Self-Equalizing Expansion Joints outlast
—by from 90% to 1200%—
any other self-equalizing
or other type of packless joint.

So, that's why you should insist
that the Zallea name be on
the next expansion joints you buy. To do so protects
both your piping . . . and your pocket book.

Zallea already has, or will make, expansion joints for every service. For information on standard types, ask for Bulletin 351. For consultation on special problems, ask to have a representative call.

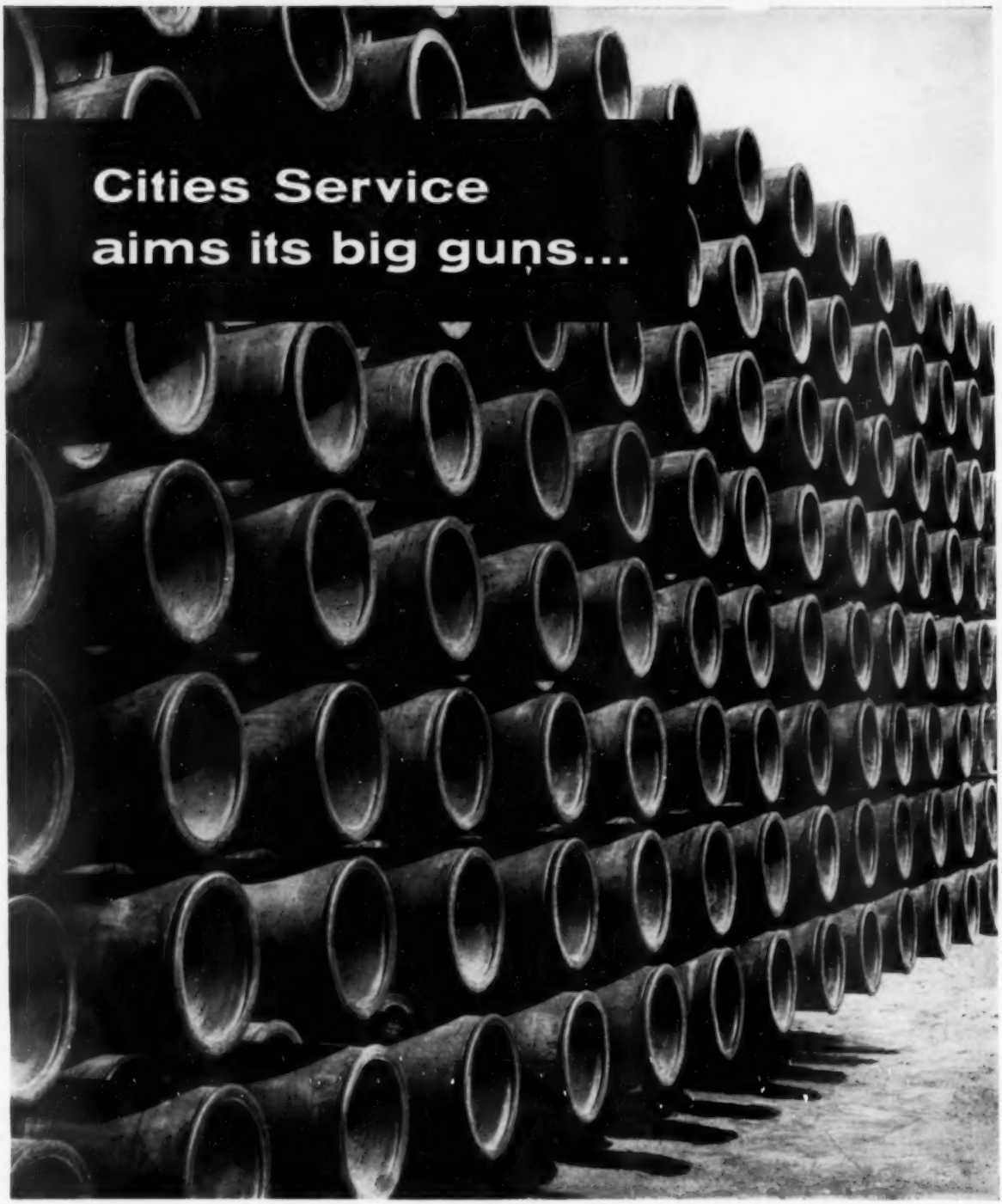


Zallea expansion joints

ZALLEA BROTHERS, 822 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints

(To obtain more data on advertised products see page 1464)



Acres of casing are mobilized in readiness at a well site. Last year an average of 1⅓ producing wells were drilled every day by

CITIES SERVICE

A Growth Company

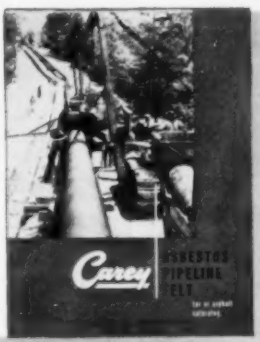
If YOUR JOB INVOLVES

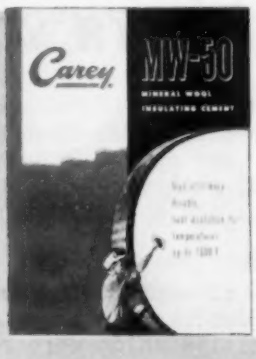
- oil or gas pipelines
- processing operations
- refinery construction or maintenance...

You need this helpful literature!

Asbestos pipeline felt data book...

a discussion of protective coatings for pipelines by a competent corrosion engineer. Covers the fundamentals of low cost, dependable pipeline protection. Timely, informative, fully illustrated.



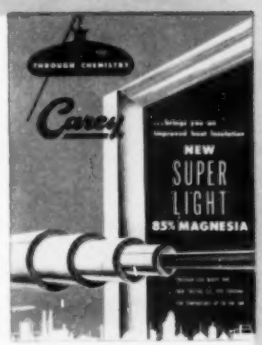


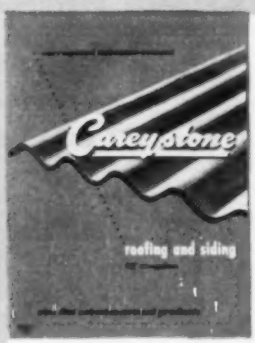
Carey MW-50 data book...

describes the most modern method for insulating all types of heated equipment having temperature ranges up to 1600°F., and gives details for applying insulation on irregular or hard-to-reach surfaces.

Super-Light 85% magnesia data book...

description, specifications and recommended uses for a new, improved insulation in precision-sized monolithic blocks, molded pipe coverings and cements.





Careystone corrugated asbestos-cement roofing and siding data book...

technical data, application details and specifications covering the economical use of Careystone asbestos-cement for all types of buildings.

Get the Carey Data Books you need absolutely free. Ask your Carey Industrial Sales Engineer, or just fill in coupon and mail today. No obligation!

Carey

ASPHALT
ASBESTOS
MAGNESIA
PRODUCTS

THE PHILIP CAREY MFG. CO., LOCKLAND, CINCINNATI 15, OHIO
IN CANADA: THE PHILIP CAREY CO., LTD. 277 DUKE ST. MONTREAL 3, P.Q.

The Philip Carey Mfg. Co.
Lockland, Cincinnati 15, Ohio
Department PP-9

Gentlemen: Please send me without charge the Carey Data Books on ☐ PipelineFelt ☐ Super-Light 85% Magnesia Insulation ☐ MW-50 Cement ☐ Careystone Asbestos-Cement Roofing and Siding. Place check mark in box before Data Books wanted.)

Name _____
Company _____
Address _____
Position _____
City _____ Zone ____ State ____

INCREASE throughput capacity
ELIMINATE costly liquid loss
IMPROVE overhead product quality
REDUCE harmful air pollution
with

YORKMESH DeMISTERS

CASE STUDY
No. 1004

VACUUM TOWER CAPACITY INCREASED 35% WITH YORKMESH DEMISTER

OBJECTIVE:

To increase feed rates from 20,000 bbl. per day to 26,000 bbl. per day without affecting gas-oil overhead quality.

PROBLEM:

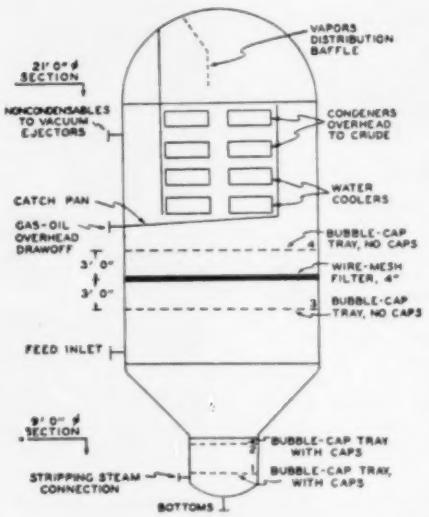
Entrainment of asphalt in the gas-oil vapors, at the high vapor velocities which were required, had made it impossible to produce a gas-oil overhead suitable for cracking feed stock.

SOLUTION:

Two wiremesh demister pads, each 2" thick and fabricated from type 304 stainless steel, placed at right angles to each other and wired together for a total thickness of 4", were installed in place of one of the original bubble trays.

RESULTS:

The use of these wiremesh demister pads increased the feed capacity 35%, and not only maintained, but actually improved the gas-oil quality.



Note: To get the facts behind this 35% tower capacity increase write for Case Study No. 1004.

YORK

OTTO H. YORK CO., INC.

6 CENTRAL AVE. • WEST ORANGE, N. J.

HEADQUARTERS FOR SPECIAL ALLOY STEEL FLANGES

25" I.D. TO 185" O.D.

You can depend on Midvale's complete facilities—melting, rolling and forging, and machining—to produce alloy flanges to the following specifications:

All standard grades of chrome-molybdenum steel from .5% chrome—.5% moly up to and including 9% chrome and 1% moly.

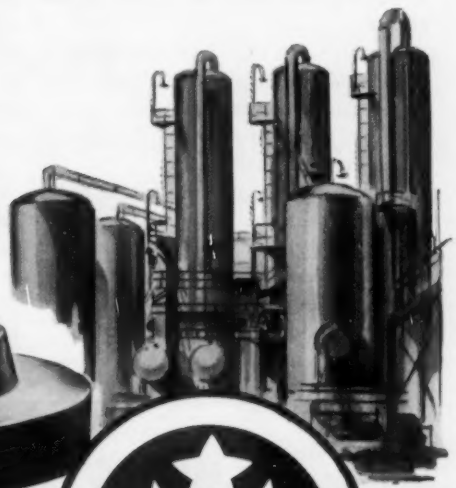
Carbon steel AISI 2317 and chrome, copper, nickel alloys to meet Charpy specifications for low temperature service.

All stainless steel generally required, such as 12-14 chrome and austenitic steels types 304, 316 and 347.

If your engineers require flanges of any unusual specifications call on Midvale.

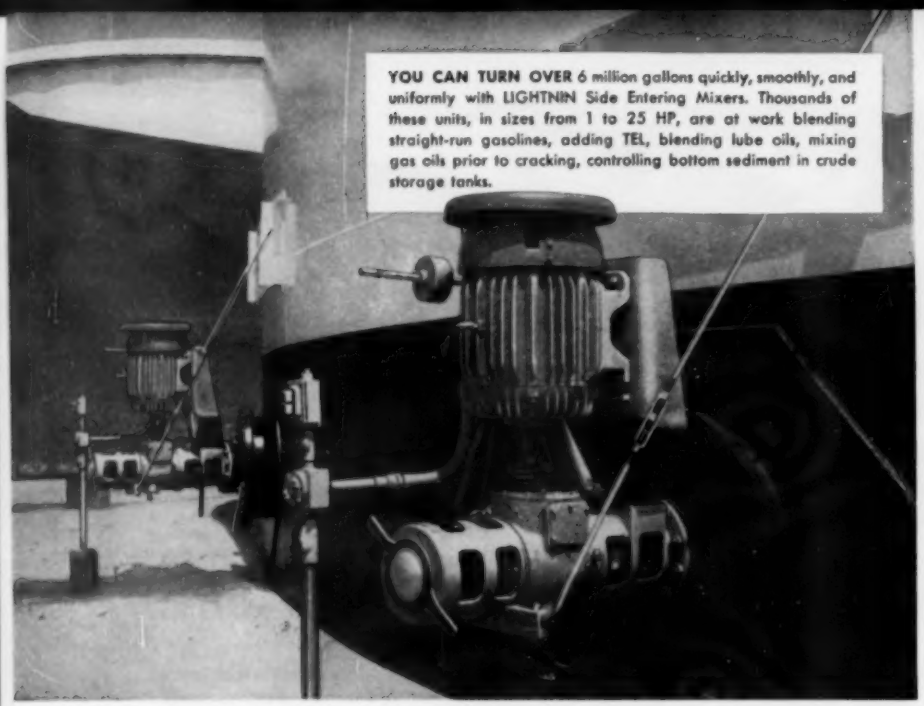
THE MIDVALE COMPANY-Nicetown, Philadelphia 40, Pa.

Offices: New York, Chicago, Pittsburgh, Washington, Cleveland, San Francisco

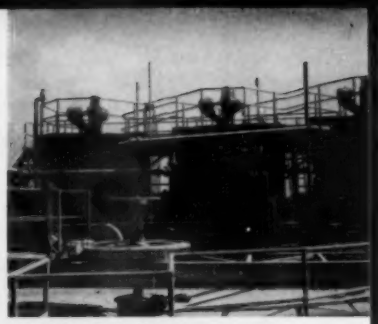


MIDVALE

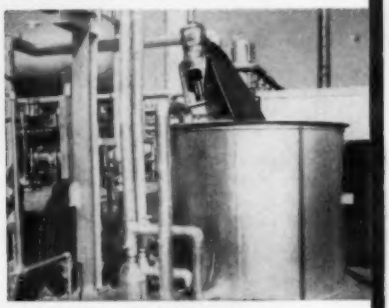
FORGINGS, ROLLS, RINGS, FLANGES, STAINLESS STEEL CASTINGS



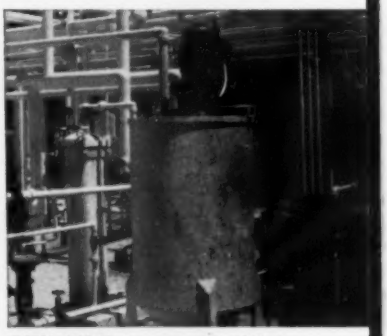
YOU CAN TURN OVER 6 million gallons quickly, smoothly, and uniformly with LIGHTNIN Side Entering Mixers. Thousands of these units, in sizes from 1 to 25 HP, are at work blending straight-run gasolines, adding TEL, blending lube oils, mixing gas oils prior to cracking, controlling bottom sediment in crude storage tanks.



CAUSTIC TREATING and other mixing jobs become fast, efficient operation with turbine-type LIGHTNIN Mixers. You can mix, blend, suspend solids, get intimate gas-liquid and liquid-liquid contact, in open tanks or closed pressure vessels with these units. Standard sizes from 1 to 500 HP provide hundreds of power-speed combinations.



FOR TANKS up to 3,000 gals., continuous or batch mixing, pipeline mixing, there are 30 LIGHTNIN propeller-type models to choose from. Sizes ¼ to 3 HP.



OPEN TANK becomes an efficient mixing vessel when you add a LIGHTNIN Portable Mixer. Over 30 models, electric or air driven. Sizes ⅛ to 3 HP.

How to be on safe ground when you plan for fluid mixing

A refinery engineer recently found he had been allowing two hours for a mixing operation that, when correctly done, took 15 minutes.

Why take chances with fluid mixing—when it's so easy to *be sure* you're right?

You can get the right data-answer for *any* fluid mixing problem—quickly, without cost or obligation—by handing the problem to your LIGHTNIN Mixer representative.

He eliminates guesswork and risk, by giving you an unqualified guarantee of *successful results.*

His approach to your problem is sound, fundamental—yet fully in step with today's processing methods.

His recommendations are based on 25 years of research and field experience on thousands and thousands of applications.

Save on upkeep, too

He can show you the way to maintenance savings you may never have thought possible with fluid mixers. A sensible program for reducing machine obsolescence, and keeping replacement costs low.

Before you select a fluid mixer for *any* purpose, find out how much time and effort you can save by checking first with MIXCO. Get the facts now on the LIGHTNIN guarantee that protects you unconditionally. Call in your LIGHTNIN representative—or write us today.

- ☐ DH-50 and DH-51 Laboratory Mixers
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-106 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet
- ☐ B-108 Portable Mixers (electric and air driven)
- ☐ B-502 Mud Mixers (oil well drilling)
- ☐ B-503 Mixers for BS&W Control

MIXING EQUIPMENT Co., Inc.

131-j Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ontario.

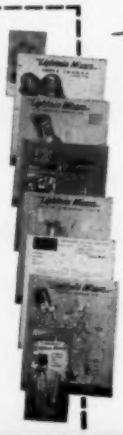
Please send me, without obligation, catalogs checked at left.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____



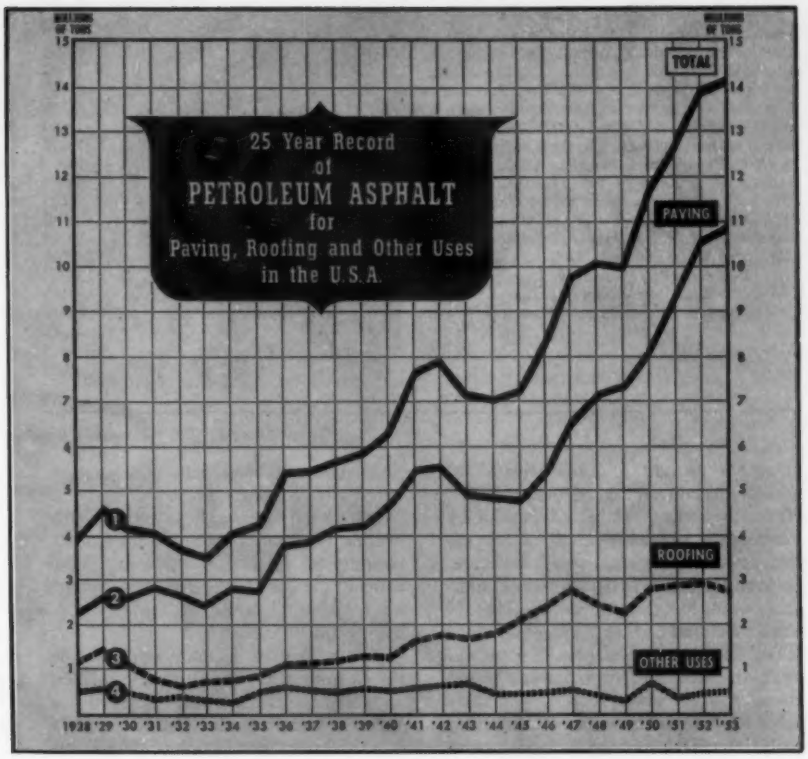
Lightnin® Mixers

GET THESE HELPFUL FACTS ON MIXING

LIGHTNIN Catalogs contain practical data on impeller selection; sizing; best type of vessel; installation and operating hints; full description of LIGHTNIN Mixers. Yours without obligation. Check and mail coupon today.

MIXCO fluid mixing specialists

PETROLEUM PROCESSING
SEPTEMBER 1954



ASPHALT DEMAND — up 250% in 26 years, with paving leading the way

Don't Sell Asphalt Short

Demand for this bottom-of-the-barrel product is growing in paving, roofing, other uses

STEADILY growing markets are improving the status of petroleum asphalt among the products U. S. refiners turn out.

Consumption of all types, including imports, in this country in 1953 was the equivalent of about 77,000,000 barrels. This is small compared with the use of the refiner's volume products such as motor fuel, but it is about double the amount of asphalt consumed 10 years ago.

Its principal utilization is in paving and surfacing highways, streets and airfield runways, where it is supplanting concrete in many instances. Over 75% of the annual production goes for this purpose. About 20% finds its way into roofing compounds. Nine-tenths of the entire annual roofing coverage of the U. S. is asphalt. There are numerous other avenues of present small volume utilization where larger potentials are expected to increase asphalt consumption in the coming years.

Production of petroleum asphalt at U. S. refineries in 1952 (data from the Bureau of Mines) was 12,784,000 short tons. This included solid, semi-sold and cut-back mixtures but not road oil. This was a gain of over 6% from 1951. Sales from refineries for domestic consumption in 1952 were 12,529,300 tons, 7% larger than the year before.

Average sales price for asphalt at the refinery in 1952, according to the Bureau of Mines, was $18.15 per ton. This was nearly 58% higher than the $11.51 price prevailing in 1945. In the intervening years the price was neves lower than in 1945 and it reached $19.45 a ton in 1948.

Reduced to a per barrel price, using the conversion factor of 5.5 barrels to the short ton, the average sales price for asphalt f.o.b. refinery in 1952 was $3.30 per barrel. Compared with this figure, the weighted average price in 1952 for residual fuel oil, the refiner's principal other by-product, was $1.61 per barrel. The average sales

Petroleum Asphalt Refineries in the U.S.

(Plants Whose Basic Product Is Listed as Asphalt by the Bureau of Mines)

Plant and Location	Crude Oil Charge Capacity, b/d
American Bitumuls & Asphalt Co., Mobile, Ala.	6,000
American Bitumuls & Asphalt Co., Baltimore, Md.	7,500
American Bitumuls & Asphalt Co., Providence, R. I.	1,500
American Bitumuls & Asphalt Co., Portland, Ore.	6,500
Edgington Oil Refineries, Inc., Long Beach, Calif.	3,500
Edgington-Oxnard Asphalt Co., Oxnard, Calif.	1,500
Esso Standard Oil Co., Charleston, S. C.	8,000
Mexican Petroleum Corp., Savannah, Ga.	5,500
Oxnard Oil & Refining Co., Oxnard, Calif.	2,000
Pabco Products, Inc., Emeryville, Calif.	2,500
Pan American Refining Corp., Baltimore, Md.	8,500
Superior Asphalt Co., Oxnard, Calif.	1,000
The Texas Co., Claymont, Del.	3,500
The Texas Co., Providence, R. I.	3,500
The Texas Co., Port Neches, Texas	40,000
Union Oil Co. of California, Edmonds, Wash.	4,000
	105,000

price for asphalt in 1945 was $2.09 per barrel, that for heavy fuel oil $1.09. However, the marketing of asphalt by the refiner is not altogether as rosy as this price comparison would indicate. Special tank car and tank truck handling equipment is called for. The asphalt seller has to own the equipment to make the applications and stand back of their performance in many cases. It is a new and different sales field for the oil company compared with the selling of conventional petroleum products.

Consumption of all types of petroleum asphalt in 1953, including road oil, was 14,087,000 tons, the Asphalt Institute estimates. Of this volume, about 10,900,000 tons were used for paving and road surfacing, 2,700,000 tons for roofing, and around 487,000 tons for miscellaneous uses, such as paints, coatings, floor coverings and so on. The Asphalt Institute data includes imports and also shipments by U. S. oil companies to their subsidiaries abroad.

The refinery manufacture of asphalt is of two types:

1—That produced from the tarry residues from thermal cracking and from the heavy extracts from the solvent refining of lubricating oils, in conventional refineries operating on mixed base crudes.

2—That refined in plants which make asphalt as a basic product, operating on selected naphthenic crudes which will give a high asphalt yield.

The asphalt produced in the first group of plants is a by-product and may run 6-8% of the crude charge. Among U. S. refineries there are approximately 45 plants making asphalt as a by-product. The plants making asphalt as a basic product are mainly located either on the West Coast, processing some of the heavy California crudes, or on the East and Gulf Coasts, running on selected Mexican or Venezuelan crudes. These refineries secure up to 55-60% yield of asphalt from the crude charged.

There are 16 asphalt refineries in the U. S. listed by the Bureau of Mines, with a total crude charge capacity of 105,000 barrels daily. The largest is a 40,000-barrel installation of The Texas Co. at Port Neches, Texas. Standard Oil Co. of California, through its asphalt division, the American Bitumuls & Asphalt Co., operates one plant on the West Coast, three on the East Coast and is building a fifth plant near Cincinnati to process crude from the Boscan field in Venezuela. Esso Standard Oil Co. operates only one asphalt plant but manufactures the product in volume at its conventional refineries.

In the refineries running to asphalt as a basic product, the selected crude is processed either in a series of shell stills or a continuous tube still. After the light oils are taken off, vacuum is used to lower the boiling point of the heavier fractions and enable their removal at a temperature low enough so the asphalt product is not "cracked." The heavy material remaining in the still may be asphalt of the required consistency or it may require further processing.

Asphalt finished by distillation alone is called "steam reduced." With some crudes the residue from distillation requires oxidation to obtain specification products. Oxidation is carried out by passing finely divided air through the still, or "converter," at a controlled elevated temperature. The resulting products are called "air blown" asphalts.

The use of asphalt for paving is increasing. In 1940, there were 95,000 miles of Portland cement concrete roads on state highway systems, the Institute reported; the high type bituminous, 51,000 miles. In 1953 the concrete total was down to 73,000 miles, the high-type bituminous up to 113,000 miles. The total of over 10,500,000 tons of asphalt of all types used for paving and road surfacing was more than double the approximately 4,500,000 tons used in 1940.

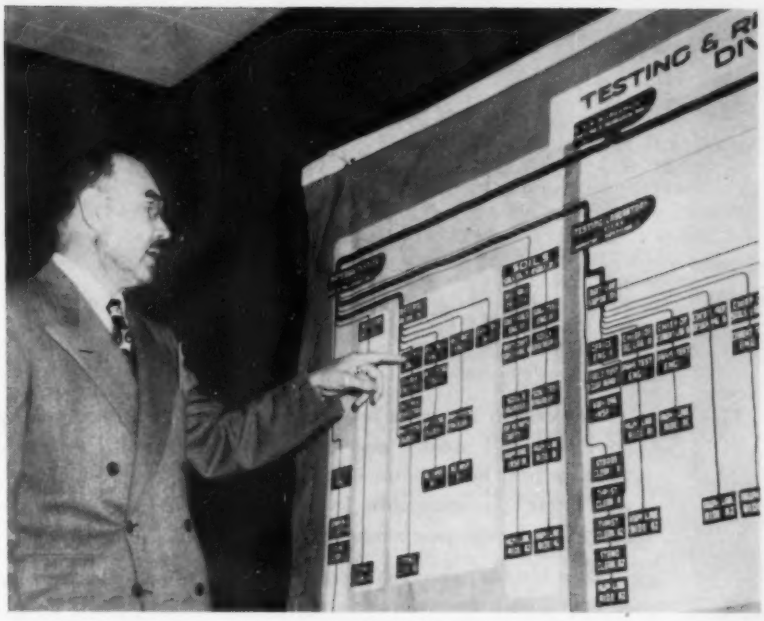
Asphalt pavement construction costs are said to run about 20% lower than Portland cement concrete of equivalent load-bearing capacity. Maintenance costs run about the same. The asphalt authorities claim the service lives of concrete and high type asphalt surfaces for equivalent load bearing conditions are about the same.

Engineers with the Asphalt Institute believe that design for both highway surfaces and air field strips is related more to tire developments than to any other one factor, since the manner of weight distribution is more important in avoiding stress on the paving surface than total weight alone. Following this reasoning, they say the substitution of the low pressure balloon tire for the former hard cord type of automobile tire, some twenty years ago, gave a big boost to the use of asphalt for paving.

Second largest use of asphalt in this country is for roofing, about 2,700,000 tons being consumed for this purpose in 1953, an estimated 19.2% of the total consumption of nearly 14,000,000 tons. In 1940 about 1,200,000 tons went to this application. From 85-90% of the entire annual roofing coverage in the U. S. is now petroleum asphalt.

The Asphalt Institute authorities believe two new large volume fields of use for petroleum asphalt in coming years will be (1) for flood and erosion control and (2) for ballast for railroad tracks.

In rivers, storm channels and ditches, for dam facings and protection of beaches and many other uses in this field, thousands of tons of asphalt annually are now being used, and authorities believe this market has hardly been scratched. The Illinois Central Railroad in 1943 installed a half-mile stretch of asphalt penetrated ballast with a seal coat in its roadbed near Manteno, Ill. The Texas Co. was among the concerns cooperating in the project. This installation has been in service for 10 years and the savings in maintenance costs have been such that this utilization of asphalt may become a volume factor in its consumption.



ASPHALT CLINICS sponsored by Leonard keep highway engineers up-to-date on asphalt and its road use, by presenting authoritative speakers such as W. W. McLaughlin, Michigan State Highway Dept. engineer

Small Refiner Finds Profits In the Bottom-of-the-Barrel

ONE refiner who has found profit in asphalt is Leonard Refineries, an independent with an 18,000 b/d plant at Alma, Mich.

Leonard got into asphalt for the first time shortly after World War II, and has concentrated its efforts so far on paving asphalt. By properly promoting the product, the company has not only built up a solid profit-maker but has also eliminated the problem of residuals in a shrinking market.

The decision to get into asphalt in 1947 was based on two observations by Leonard's management—first, that the market for residuals was becoming less attractive, and, second, that the nation's highways (long neglected during the war years) were in for a surge of increased attention—and therefore presented a promising market for asphalt.

To boost asphalt output and reduce residual yields, Leonard changed to a Wyoming crude, selected to meet quality specifications for a high grade product.

Leonard's asphalt capacity up until 3 years ago was about 2,000 b/d of charge stock. At that time, in order to satisfy increasing demands, Leonard installed oxidizing facilities and expanded its blending equipment for various grades of asphalt.

Last September Leonard completed a modern vacuum unit for asphalt with a design capacity of 4,500 b/d of charge stock. However, with the present tower, capacity can be stepped up to 10,000 b/d.

The new vacuum tower is 50 ft. high and 11 ft. in diameter, and is clad with stainless steel. It operates at a pressure of 30 mm. Hg absolute, and was designed by Refinery Engineering Co. of Tulsa.

Leonard has winter storage for about 185,000 bbl. of asphalt. About 60% of the road asphalt produced is of a cut-back type, which is shipped and used cold.

One advantage which Leonard has is that it sells in a relatively small marketing area—covering only southern Michigan, exclusive of Detroit. On top of that, the refinery is located about in the center of the area. That market and that location give Leonard an enviable advantage—the ability to deliver hot asphalt by tank truck direct to the point of application.

Approximately 90% of Leonard's asphalt is shipped hot in insulated tank trucks. Leonard operates 30 to 35 tank trucks for asphalt delivery, making from 50 to 60 trips per day. Insulated trucks are primarily for long hauls.

To help promote its asphalt, Leonard conducts "asphalt clinics" every other year. The clinics are held at the refinery, they are attended by highway engineers from throughout the state of Michigan, and their purpose is to present a panel of speakers recognized throughout the road-building industry as authorities in their particular fields.

Clinic topics over the years have included such subjects and speakers as:

"Demonstration and Explanation of Various Tests"—Ward K. Parr, acting supervisor of laboratories, Michigan State Highway Dept.

"Asphalt as Used in Road Construction Today"—F. K. Evans, engineer superintendent, Ingham County (Mich.) Road Commission.

"Asphalt and Its Many Uses"—Col. Walter F. Winters, chief engineer, Asphalt Institute.

"Triple Sealing of Secondary Roads"—A. L. Burridge, consulting engineer for 15 northern Michigan counties.

"Black-Top Maintenance" — J. S. Schaub, Michigan State Highway Dept.

"Types of Asphalt Construction and Grades of Cut-Backs"—A. H. Hinkle, district engineer, Asphalt Institute, Cincinnati, Ohio.

"Preparation of Existing Roads for Black Top"—A. M. Williams, engineer, Ionia County (Mich.).

"Whys and Wherefores of Michigan State Highway Testing"—W. W. McLaughlin, testing and research engineer, Michigan State Highway Dept.

"Soils and Highway Base Structures"—Olaf Stokstad, Michigan State Highway Dept.

The clinics have proved well worth while. They are helpful to the road engineers who attend, providing a clearing house for new ideas on asphalt construction. They are helpful to Leonard's sales by acquainting customers and prospective customers with the facilities Leonard has for serving their asphalt and petroleum needs.

Leonard is expanding its asphalt activity, and currently is branching out into the industrial asphalt field on an experimental basis. The company hopes that by adding industrial asphalts to its line it will be able to bring its asphalt production into 12-month balance. With the bulk of demand at present being for paving asphalt, the plant operates at full capacity during the warmer months, with production dropping off during the winter. By building up a demand for special asphalts in the industrial line, winter production can be stepped up.

"THERE IS STILL A QUESTION as to whether the industry is seriously 'over-built.' There may be some genuine new economic influence (other than 'boom psychology') that forces refiners to run their equipment with less down-time than during the era between the end of World War II and the start of the Korean War—

"But, unless there is such a factor, a large part of the current difficulty with surplus products can be attributed to plain old over-exuberance and inattention to the laws of supply and demand."

Bruce K. Brown

A Push or a Fall?

Petroleum industry leaders, increasingly disturbed by mounting oil stocks and the need for cutting refinery throughput, have been asking: Is the industry overbuilt, and who is responsible for the apparent surplus of refining capacity—government or industry?

One leader who has examined this situation carefully is Bruce K. Brown, president of Pan-Am Southern Corp., formerly deputy administrator of the Petroleum Administration for Defense during the Korean War (when the large-scale expansion program got going) as well as former deputy administrator of Petroleum Administration for War during World War II.

Mr. Brown posed this question for a study: "The domestic petroleum refining industry—did it fall into the pit of over-building, or was it pushed?" He believes there is no pat answer but thinks that overbuilding was caused by some of both.

When a man stands squarely up to an issue and speaks out or writes with firmness and conviction, lesser mortals can be glad such a man is representing them. Such a clear-cut statement regarding the current "tough" situation in refining can be found in this issue.

For one of the best interpretive, common-sense approaches to this problem we urge you to read this analysis of what seems to be over-built refining capacity in the United States today. Mr. Brown is probably one of the most qualified industry (and/or government) leaders in the country today to speak on this subject.

We will not attempt to summarize or even paraphrase any of the eloquent remarks. But we do suggest that you study what Mr. Brown has to say and pass the article along to any subordinates who may not have had an opportunity to see it.

Too often, there is "over-exuberance," as Mr. Brown puts it, and not enough sober, careful thinking whenever even a minor crisis arises in America's economy. It therefore has given us great pride to know that thoughtful reflection and analysis can come and is coming from industry leaders when it seems to be needed.

The Editors

IN recent months a surplus of refined products has caused a weakening in product prices. This has, in turn, created a generally unsatisfactory economic situation for petroleum refiners. There is no doubt that the capacity of United States refineries to turn out refined petroleum products exceeds the current demand.

For that matter, the same situation appears to prevail on a world-wide basis. One of the most popular diagnoses of the economic illness besetting the industry has been voiced by oil men who say:—"Well, the government asked us to expand refining capacity because of defense needs and we did it."

Because I was the Deputy Administrator of PAD who made the request of the refining industry, I naturally have a deep interest in the discussion of whether governmental encouragement of over-building is the root of the present difficulty. Since the topic is being so widely discussed, it has occurred to me that I may be of some service by recalling some recent history in perspective and, perhaps, shedding a little new light on the subject.

Briefly, so an impatient reader will not be deceived, I will concede in advance that I am of the opinion that the request made by government did stimulate refinery building, and I will admit that I do not have any ready remedy to suggest to avoid future product surpluses.

Nevertheless, I hope that petroleum refiners will find it of interest and benefit to read through to the end. A review of the history recited may help someone else evolve a helpful plan. Also, as I shall point out at the end, the problem is not a temporary one.

1,000,000 b/d Target—Early in the defense program the PAD did urge that basic petroleum refining capacity in the United States be expanded. The first target was to increase capacity by one million barrels a day. This increase was to be accomplished over a three-year period, i.e., 1951, 1952 and 1953. The recommendation was based on a forecast of future demand related to then-available refining capacity. The increased demand did develop, as forecast. The refining industry did achieve the goal set for it. The Korean war was fought.

However, no refiner would aver that the government actually "twisted his arm" and *made* him install basic refining capacity against his better judgment. The strongest compulsion used was to offer refiners the option of claiming depreciation (for tax purposes against profits) on part of the new investment at annual rates approximately double those usually accepted by the Treasury Department for refining equipment. This inducement device was included in the 1950 Revenue Act (as it had been in the Revenue Acts applying during World War II) and is referred to as "accelerated tax amortization." The press usually calls it "fast tax write-offs." But before we delve into the subject of inducements by government, let us look at the history of the expansion of petroleum refining in the last ten years.

Expansion History

Practically no expansion of basic refining capacity occurred during World War II. Two new refineries having a then-capacity of 100,000 b/d were constructed but little else was done to increase crude runs. A billion dollars was spent on special aviation gasoline facilities and about a billion dollars on equipment to make synthetic rubber raw materials and petrochemicals. At the end of 1945 (shortly after "V-J day") our national refining capacity was 5,260,000 b/d. What has happened since is shown in the table below. The figures for 1945-50 were obtained from a release of the Petroleum Administration for Defense (PAD No. 55, April 4, 1951). The figures for the later years are from "Facts and Figures About Oil" as published by the American Petroleum Institute in May, 1954.

Year	Refining Capacity (B/D) at Year End	Year	Increase in Capacity	% Gain
1945	5,260,000	1946	215,000	4.1
1946	5,475,000	1947	465,000	8.5
1947	5,940,000	1948	400,000	6.7
1948	6,340,000	1949	260,000	4.1
1949	6,600,000	1950	300,000	4.5
1950	6,900,000			
(Total expansion over five years 1,640,000)				
(Average yearly expansion for five years 328,000)				
1951	7,332,885	1951	432,885	5.9
1952	7,638,661	1952	305,776	4.0
1953	8,079,661	1953	441,000	5.4
(Total expansion over three years 1,179,661)				
(Average yearly expansion for three years 393,220)				

The tabulation shows that in the approximately five-year period between the end of World War II and the effective starting date of a new "defense program" (a few months after the Communist invasion of Korea), the domestic refining industry increased its capacity by 1,640,000 b/d. This was an average of 328,000 b/d per year. In the three defense program years ending December 31, 1953, the industry accomplished a further expansion of 1,179,000 b/d. This is an average of 393,220 b/d per year.

From these figures an unfriendly observer could well remark that—"peace or war—the industry is just doing what comes naturally." An expansionist industry in an expansionist economy is expanding. It expands in peace time and it expands when war threatens. The same critic might go so far as to belittle the efforts of government to induce industry to expand—saying—"the figures prove that it would have happened anyway."

"I DOUBT that as much would have been built (without tax writeoff)."

Original Goals—The whole situation presents an interesting anomaly. It has been suggested that the present products surplus is due to over-encouragement by government during 1950-53 to expand facilities. However, the figures alone don't demonstrate that the government accomplished very much; because the rate of increase during the "defense program" is about what it had been before. The original goals for the expansion of basic refining capacity, as distinguished from the needed expansion of aviation gasoline manufacturing capacity, at the start of the defense program under the Defense Production Act of 1950 were announced to the industry in a speech given by me before the Western Petroleum Refiners Association at San Antonio, Texas, on April 4, 1951.

After reviewing the refining expansion that had occurred since the close of World War II (which, I pointed out, had averaged about 300,000 barrels per day per year over five years), I said:

"In recent months at least, the presently installed refining capacity of

United States refineries has been pressed to supply the demand for products . . ."

"It is obviously 'time' to build some more refining capacity. After evaluating the upward trend of ordinary peacetime civilian demand plus the anticipated impacts of mobilization (not war) demand for military products the Petroleum Administration for Defense has reached the conclusion that unless approximately 700,000 b/d of new capacity is added to the nation's productive capacity by the end of 1952 the public may again be plagued with product shortages of the type that threatened in the immediate postwar period. This is a most conservative estimate and allows nothing for the possible impacts of actual war—either from the standpoint of increased demand nor from the standpoint of losses by sabotage or enemy action anywhere in the allied world. Nor will it be possible to stop building after 1952. Peace or war, building will have to continue. By the end of 1953 the figure should exceed 1,000,000 b/d. By the end of 1956, it should exceed 1,600,000 b/d."

The three-year period for which the million-barrel goal was set expired last December 31 and as the figures previously cited have indicated, the industry overshot the original goal by almost twenty per cent.

However, in February, 1952, a new goal for basic refining expansion was announced (PAD release 259, February 20). The release stated that sufficient basic refining expansion projects had cleared PAD and had been recommended for certificates of accelerated tax amortization so that no more applications were being processed. However, the announcement added:

"Recently, however, PAD submitted a revised petroleum industry expansion program for Defense Production Administration approval that calls for stepping up the rate of basic refinery expansion to a yearly rate of 475,000 b/d (instead of 330,000 b/d) in the last half of 1952 and all of 1953."

The statement added that if the revised program was approved by DPA, the Petroleum Administration for Defense would resume processing of applications for certificates for accelerated tax amortization for additional basic refining facilities.

The Defense Production Administration acted in March 26, 1952, giving approval in the following words:

"Construction of basic crude oil refining capacity at the rate of 250,000 b/d during the last half of 1952 and 500,000 b/d in 1953, thereby bringing total refining capacity to just under 8,000,000 b/d as of the end of 1953."

The Big Question

It is interesting indeed to note from the figures previously cited that the domestic industry did achieve almost exactly the refining capacity specified by DPA at the end of 1953.

The question for consideration is whether the government's plea for increased basic refining capacity was effective or whether the increase would have occurred anyway even if no appeal had been made and no inducement offered.

In my view, the government has been, to some important degree, although not principally, responsible for the increase in refining capacity since the beginning of the Korean war. It offered a real incentive for expansion when it offered accelerated tax amortization in a time of high corporate taxes for all refiners and excess profit tax considerations for many refiners.

In setting the pattern for government aid to the needed expansion, the WPRA was told in April, 1951:

"Noting the past history of refinery expansion, we observed that so long as the industry had the market-expectancy *and* the expectancy of being able to recapture the funds invested in the form of a reasonable 'pay-out' on its investment it had, in the past, always attended to its own problems and met its own responsibility to the public. So long as the necessary basic refining capacity is constructed by private enterprise with its own money and its own legitimate borrowing capacity or credit, we can count on usual business prudence being exercised by such enterprises . . ."

"However, we recognized that the necessary higher income taxes levied on corporations as the result of the mobilization effort might drastically reduce, or even eliminate, hope of securing enough net tax-free revenue to recoup the cost of a refining unit (i.e., get a 'pay-out') within a reasonable period of years. For this reason, PAD in the first months of its operation has recommended to the Defense Production Administration that certificates be issued permitting the acceleration of the normal period of depreciation of the cost of new refining equipment —say 12 years—to the five-year period permitted under the law. These recommendations, which have been uniformly accepted by DPA, have been for amounts less than 100% of the cost of the new equipment. In the case of basic refining equipment, a figure of 75% has been used."

Disagreement in Washington — So much for the open invitation given to the refining industry to expand. Behind the scenes in official Washington there was, as usual, some disagreement. Actually there was a widespread difference of opinion in Washington in the spring of 1951 concerning the propriety of, yes—even the significance of —the granting of accelerated tax amortization to induce private industry to build basic refining facilities, as distinguished from "war product capacity" such as avgas equipment. While the "men from industry" drafted into government to spur on the defense production program generally favored the plan, a large number of permanent government employees were opposed and fought it as much as they dared.

The PAD had its difficulties in putting its program into effect within government because its policy was under continuous criticism by the "defense

"INDUSTRY OVERSHOT the original goal by almost 20%."

production staff" of the Secretary of the Interior.

The Deputy Administrator's speech to the WPRA naturally came to the attention of this group and they seized upon some of the data given in it as an argument against the necessity of offering the tax incentive to the refiners. In a letter to the Deputy Administrator commenting on the speech, the Secretary's staff experts referred to the data which had been given the WPRA showing that over the five-year period refining capacity had increased at the rate of about 300,000 b/d per year, and said:—

"It is not clear that industry needs the high degree of incentive represented by the present high levels of accelerated tax amortization . . ."

"It would seem that the 1 million barrel expansion contemplated in the next three years is not far out of line with past experience. Might we not have anticipated that a very substantial portion of this expansion program would have proceeded under normal circumstances?"

In reply we said:—

"You strike at the very heart of the matter . . . we are not living under 'normal circumstances,' but under an approximate 77% corporate tax rate. What the speech said was averages are always deceptive. Here is the real record as revealed in the speech and the reasons:—

		Increased b/d	Reason
Last Half	1945	10.000	War and material shortages
	1946	215.000	Future uncertain and relative surpluses
	1947	465.000	Boom-good profits, good capital formation
	1948	400.000	
	1949	260.000	Slump hit refining business in October 1948
First Half	1950	150.000	

"Industry Cancellations—The drop in 1949 reflected directly the unsatisfactory economic situation of the refining industry. Commencing in October 1948 and continuing until about February or March 1949, units of the refining industry canceled more than $100,000,000 and probably $200,000,000 worth of construction projects for the simple reason that they could not see a pay-out ahead.

"Your memorandum puts the finger right on the point—namely, that the refining industry cannot build refining capacity except to the extent that it can form capital, and it cannot form new capital to any considerable degree under the present tax structure. It cannot get a 'pay-out' on an investment."

Speaking from the vantage point of over three years later, I believe that time has substantiated the point expressed to the staff of the Secretary of the Interior in the spring of 1951. It appears that the availability of accelerated tax amortization did provide a real stimulus for the building of basic refining equipment. Certainly a lot of equipment would have been built without that stimulus, but I doubt that as much would have been built—possibly not more than half as much.

It will be understood that I am referring to the refining equipment used to make ordinary products. In the case of aviation products the stimulant provided by the industry's keen sense of responsibility for military supply was probably more effective than the temporary tax benefit offered. Indeed the refiners knew that a Korean peace could bring an overproduction of avgas.

On the other hand, a conclusion that the current over-supply of ordinary petroleum products is due to the tax stimulant offered by the government would reflect more on the wisdom of business than the wisdom of government and I don't think such a conclusion is justifiable. The refiners do know that the availability of accelerated tax amortization is *not* a reason, in itself, for building industrial capacity. The proprietor of a business must have a belief that he can sell the products from the increased capacity—*and at a profit* before the tax incentive takes hold.

In other words, the pronounced business expansion that grew out of or at least accompanied the Korean defense boom must be one important reason for the refining expansion of the past few years.

No amount of incentive consisting solely of a permission to postpone the payment of part of the corporate income tax that must be paid eventually anyway (if the business is a profitable one) could possibly induce a refiner to build equipment he didn't think he could use at a profit.

I am of the opinion that the tax amortization incentive did what it was intended to—namely, it put the refiners back in a "pre-Korea" position—i.e., one in which they could build the basic refinery equipment that they thought would be useful to them and profitable for them with the possibility of a "pay-out" approximately as good as they used to get before taxes became so severe.

Is it Overbuilt?—There is still a question as to whether the industry is seriously "overbuilt." There may be some genuine new economic influence (other than "boom psychology") that forces refiners to run their equipment with less "down time" than during the era between the end of World War II and the start of the Korean war—but, unless there is such a factor, a large part of the current difficulty with surplus products can be attributed to plain old overexuberance and inattention to the laws of supply and demand.

Future Trouble

One final point, and then I am through. As I have said—if the accelerated amortization tax incentive offered by government to stimulate the building of basic refining equipment (and it is still in effect as of the present writing) is such a temptation to refiners as to cause them to act unwisely insofar as their own interests (and industry-wide interests) are concerned, then we are due for more trouble in the future. The old pre-Eisenhower administration tax policy was to permit "fast tax write-offs" only with respect to such new industrial facilities as governmental authorities would certify were essential to the defense (or war) program.

"SUBSTANTIALLY AS BIG a tax concession (is being written into law)."

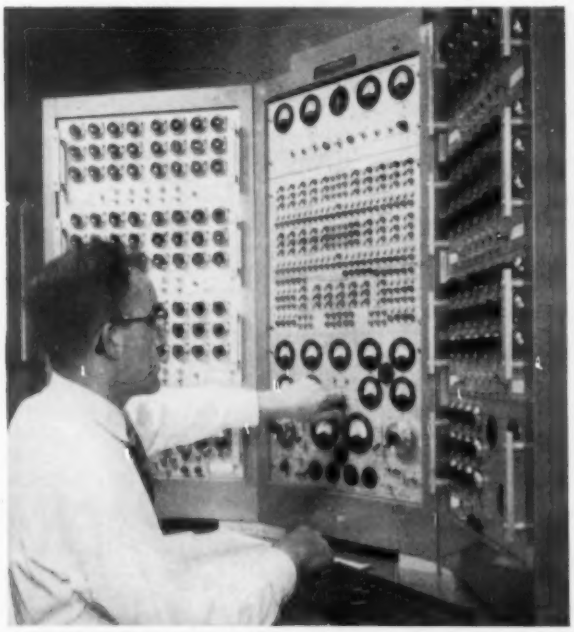
[*Editors Note*: The new bill, passed by both the House and the Senate and with bipartisan support, has written "fast tax write-offs" into the law.]

Under the provisions of the bill, no certificate of essentiality by any governmental agency is required. The principle can be applied, at the option of the tax payers, in all industries.

Under the "declining balance method" of depreciating new equipment for tax purposes roughly two-thirds of the value can be written off in the first half of the depreciation period. Assuming a normal life of ten years for—say a catalytic cracking unit—a refiner choosing the declining balance method of depreciation can write off two-thirds of the cost of all new refining equipment over five years. That is about three quarters as great a tax concession as refiners have received on equipment built and building since 1951. And the "other incentive," that is, the urge to be able to fuel a major war, is still with us. Crude producing capacity and refining capacity have not risen to that level.

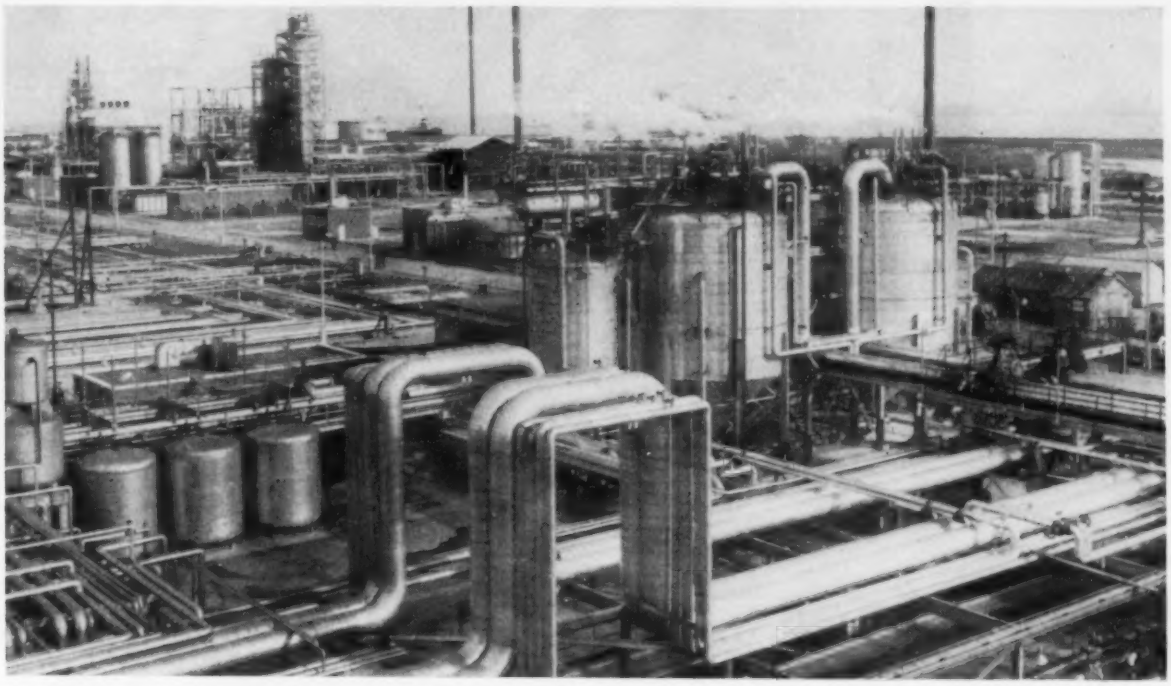
The text of the preceding article was made available exclusively to McGraw-Hill's petroleum publications, by Mr. Brown, and was published also in the July 21, 1954, issue of *National Petroleum News*.

CALIFORNIA'S FIRST REFINERY, at Newhall, is this tiny plant, now restored as an historical monument. Built in 1876 by a predecessor company of Standard Oil Co. of California, it indicates the growth of the industry on the Pacific Coast. California Standard itself observes the 75th anniversary of its corporate history on Sept. 9, the date when a small group of visionary oilmen founded Pacific Coast Oil Co.

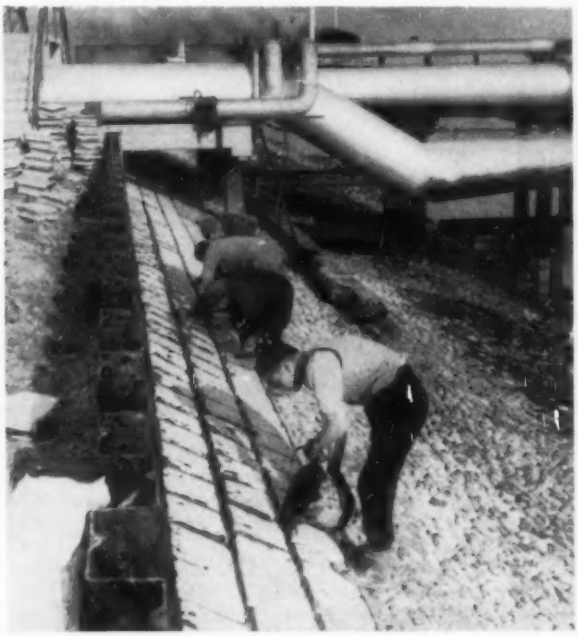


ASSIST FROM AN ABACUS: Doug McGowan of California Standard's research laboratory uses a centuries-old "instrument" to keep track of blending problems he solves on a modern electronic computer because the beads keep "things from going haywire."

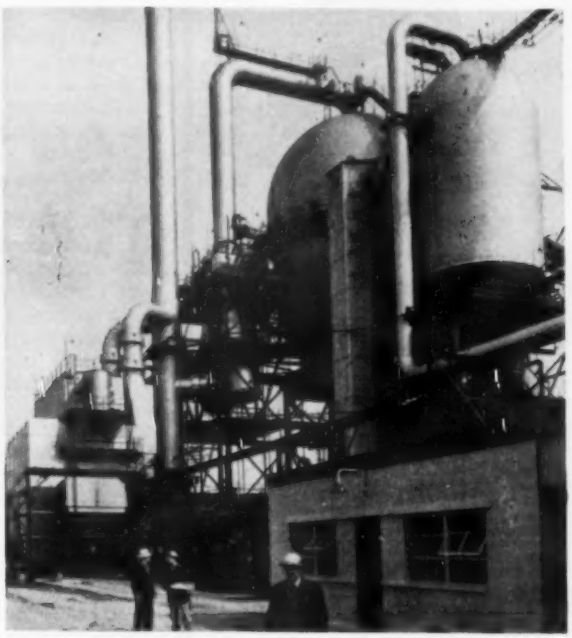
ONE-FOR-EIGHT: Russ Mills, Standard Oil Co. (Ohio) and C. A. Schroeder, General Electric, examine what is believed to be world's most powerful inert-gas filled motor, which will replace eight reciprocating engines to drive a Sohio gas compressor.



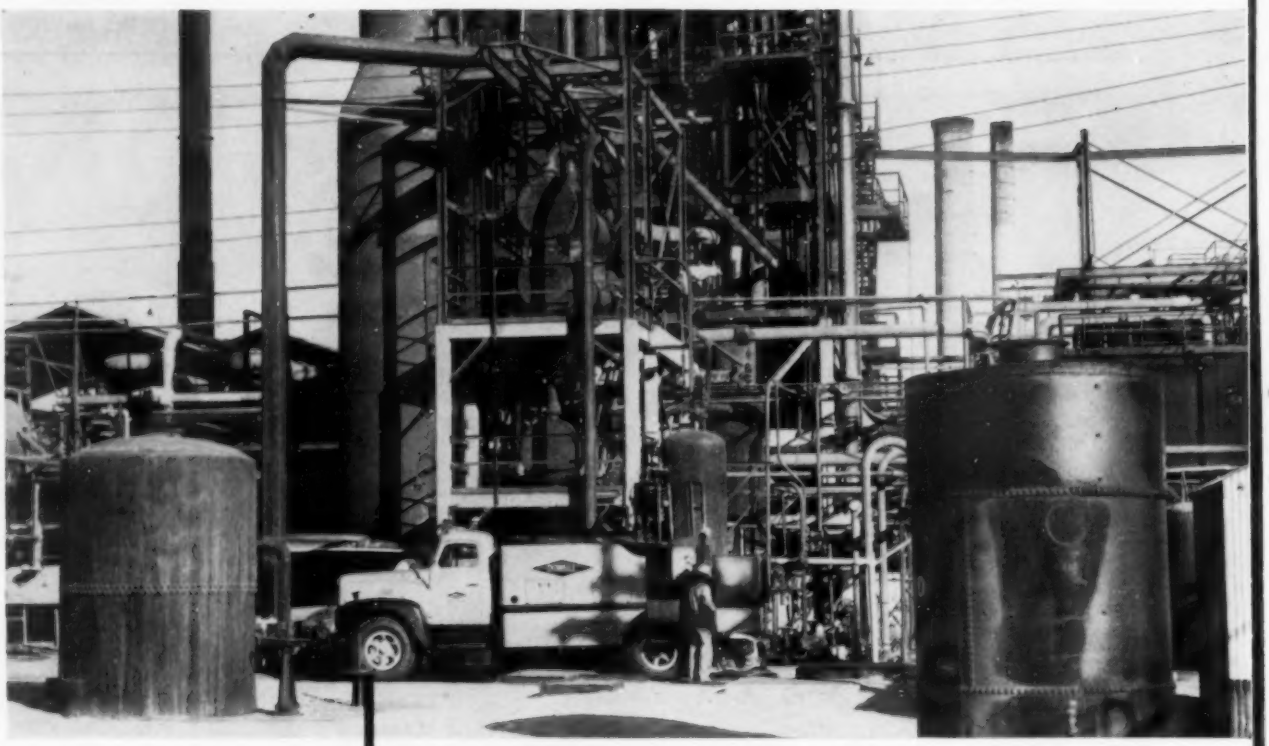
ENGLAND'S NEWEST REFINERY, Vacuum Oil Co.'s plant at Coryton, placed on stream in the past few months, is shown in this general view, with the water treating unit in the immediate foreground. This refinery is designed for 17,700 b/d, cost $42,000,000, and took 3½ years to build. At left background is a 9000 b/d Thermofor catalytic cracking unit. Products include gasolines, Diesel and fuel oil, lubes.



DISASTER PREVENTION at Vacuum Oil's Coryton refinery is demonstrated by these reinforced sea walls. Plant had to be rescued from the sea in 1953 when gale-swept tides flooded England's east coast, breaching these dikes.



WORLD'S LARGEST catalytic cracking unit—up to now at least—is this recently completed Fluid "cat," of 63,750 b/d design capacity at Gulf Oil Corp.'s refinery in Philadelphia. Unit is slightly larger than Gulf's Texas cracker.



TYPICAL TECHNIQUE for cleaning piping is in-place flushing with chemicals and solvents

TYPICAL TOOLS for cleaning transfer lines are the "pig" (above), and the "mole" (below)

Cleaning Plant Transfer Lines

By S. J. MARTINEZ and C. W. MICHAELS, Jr.
Dowell, Inc.

THE miles of pipe within a refinery or petrochemical plant are vital to efficient operation. During use, however, deposits tend to accumulate, partially restricting the passage of fluids. The capacity of the pipe is diminished and higher friction losses result, requiring additional power to move the fluids.

When these lines fail to carry sufficient quantities, plant operation is seriously hampered. Unscheduled shut-downs may result. Deposit accumulations may also reduce heat transfer, resulting in increased fuel consumption and subjecting equipment to more rapid deterioration due to excessive temperatures.

Such deposits may consist of minerals precipitated out of water or brine, and other solid materials which have dropped out of the fluid stream and become cemented together.

During recent years this recurrent problem has been greatly simplified by the development of effective chemical cleaning procedures. The application of various types of chemical solvents, using auxiliary mechanical aids, or "tools," where necessary, has been utilized successfully for the removal of practically all kinds of deposits from many different types of lines and plant equipment, including large vessels and tanks. These solvents either dissolve the deposits or so loosen the binding materials that the disintegrated deposit may be flushed away. A line normally requiring many weeks to clean by mechanical methods alone frequently can be chemically cleaned in less than 24 hours.

Chemical cleaning possesses a number of additional advantages:

1—It is conducted with the lines in place, eliminating the need for dismantling or long, costly shutdowns.

2—The liquid solvent flows through the line, contacting the deposit re-

(Continued on page 1368)

11 Examples of Successful Transfer Line Cleaning

1—Fresh Water Lines

Deposits of iron tuberculation, silt, and sludge had collected in a refiner's water supply line. This line consisted of 11,000 ft. of 10 to 16-in. diameter pipe, some of which ran under a bayou and the rest of it above ground. The line was filled with 102,000 gal. of chemical solvent and allowed to soak for 24 hrs. It was then flushed and returned to service. The full capacity of the line was restored, eliminating the need for replacement.

2—Water Lines

Deposit build-up restricted the carrying capacity of a refinery water line, connecting the water wells with a storage point. The line consisted of some 600 ft. of 6-in. steel pipe, with bell-and-spigot joints. The internal diameter of the pipe had been decreased from 6 to about 3½ in. by iron oxide scale. The "pig" was used on this job, and approximately 98% of the deposit was removed with a single pass. This line had a number of 45° ells in it and at one point passed under a river; however, no difficulty was experienced with the "pig" sticking.

3—Water Line

A southern refinery had 1200 ft of water line that had not been cleaned since its installation, 25 years previously. It was heavily encrusted with scale, resembling stalactite cave formations, up to 3 in. in thickness. Approximately 85% of the deposits were removed using water in conjunction with the high pressure jet "mole."

4—Cooling Water Lines

The lines supplying the overhead vapor condensers on a pipe still had become scaled-up until the through-put was reduced from 72,000 b/d to 63,000 b/d. Since the plant could not be shut down, due to a heavy production schedule, it was necessary to clean these lines while in operation. Concentrated solvent, introduced into the cooling water, dissolved the deposit, increasing the through-put to 70,000 b/d and permitting the plant to remain on stream.

5—Aluminum Tubing

A chemical plant had 1250 ft. of 4-in., and 850 ft. of 2½-in. aluminum pipe handling demineralized water. Special cleaning procedures were required due to the nature of the line. Hot water was first circulated through the pipe to heat the metal, after which the line was filled with specialized solvent, non-corrosive to aluminum. After soaking for two hours the line was flushed with well water, then with demineralized water, and returned to service.

6—Sewer Line

A midwest refinery had a serious problem with calcium carbonate deposits clogging the main sewer line. The inside diameter of this pipe, originally 20 in., had been reduced to approximately 4 to 6 in. by the heavy scale accumulation. It would no longer handle the volume of waste liquids produced by the refinery each day. The "fill-and-soak" method was employed to restore this line to its original capacity. An estimated 392 cu. ft. of scale was removed in six days' time, and the line was restored to its capacity of 1,300,000 gal./day of water.

7—Storm Sewer

An underground sewer line in a chemical plant, consisting of 1250 ft. of 20-in. and 24-in. piping had become entirely blocked in some places, causing the water to back up into the plant. In spite of the large quantity of deposits present, the line was readily cleaned, using the jet "mole." The deposits were knocked loose by the jets, and washed on out of the line by means of a fire hose. This line was cleaned in sections, working from manholes located at 150-ft. intervals along the line. The job required 16 hrs. and the sewer was completely opened up.

8—LPG Line

An 80-mile line of 4-in. O.D., was designed to carry 6000 b/d of liquid petroleum gases from a refinery to a nearby petrochemical plant. A ¼-in. thick deposit of iron sulfide had reduced the line capacity to 3700 b/d and was curtailing operations in the petrochemical plant. Five stages of acid solvent followed by alkaline solution were pumped through the line, which was put back into service after hydrostatic testing. Capacity after cleaning was 5,200 b/d.

9—Tank Farm Lines

A refinery tank farm had an underground system of communicating lines consisting of 4000 ft. of 24-in. main lines and twelve 100-ft. sections of 24-in. laterals, for handling crude oil. It was desired to convert from crude to kerosene, however, these lines had a heavy coating of greasy wax deposit. The main line was cleaned out, using the "pig," and the jet "mole" was used on the laterals, in conjunction with hydrocarbon solvent. The job required a total of 73 hrs. and the deposit was satisfactorily removed.

10—Sour Crude Lines

A total of 900 ft. of 6 and 8-in. line, connecting refinery pre-heat exchangers with the pipe stills, contained from 1½ to 2 in. of oily polymerized hydrocarbon material. Previous attempts to remove the deposit had been unsuccessful. The jet "mole" was used for this treatment, jetting water at high pressures. Due to the length of the line, it was necessary to tap it at intervals, allowing the "mole" to pass through a section at a time. Using this procedure, the line was cleaned completely in 24 hrs.

11—Process Lines

A series of lines in a synthetic rubber plant, supplying hot, cold, and tempering ethylene glycol solutions to the foam rubber presses, had built up deposits of copper, iron oxide and corrosion products. Constant plating and replating of the copper (from associated heat exchangers and expansion joints) was causing severe corrosion in all the lines. Over 7000 ft. of 2, 4 and 6-in. lines were chemically cleaned, and the troublesome copper deposits removed, in approximately 60 hrs. time.

Types of Transfer Lines You Can Clean

Water lines	Product Lines	Auxiliary lines
Fresh water	Raw materials	Hydraulic fluids
Cooling water	Process fluids	Compressed gases
Boiler feedwater	Products and by-products	Lubricant oils
Treated water	Waste materials	Fuels and exhaust gases
Sewage		Refrigerant

gardless of the intricacy or inaccessibility of the line.

3—The expense of line replacement has been avoided, in many cases, by the utilization of chemical cleaning procedures where other cleaning methods were not applicable.

4—Pits resulting from operational corrosion are also cleaned out, lessening chances of galvanic corrosion caused by the presence of pits full of scale adjacent to clean metal.

5—Experience has shown that the cleaner surfaces remain clean longer.

Where corrosion has been severe enough to result in perforation of the piping, chemical cleaning will reveal such holes. They may then be repaired at one time, rather than during a number of unscheduled shutdowns.

Existing connections are usually satisfactory for introducing the solvents. Disassembly of equipment is minimized. Frequently, lines have been chemically cleaned during operation. The improved line efficiency rapidly compensates for the time and expense of chemical cleaning.

While it is possible for a manufacturing plant to conduct its own chemical cleaning operations it is usually more practical to employ a chemical cleaning service company. By the use of specialized equipment designed for this specific application, the cleaning operations are considerably simplified. Also, a high degree of "know-how" is required, not only in selecting the proper solvent but in determining the most effective method of application.

Chemical Procedures

The various types of lines found in refineries, chemical plants and other industrial installations operate under diverse conditions of temperature and pressure. Many different fluids are carried through them and the deposits formed differ correspondingly.

The physical and chemical composition of the deposit thus is a direct function of the fluid from which it is produced and the conditions under which deposition takes place. Since there is no universal "cure-all" for the removal of deposits from lines, it is important that a thorough examination be made of the line to be cleaned.

Samples of the deposited material are removed for examination. X-ray and spectographic analyses can be performed by the laboratory in the case of more complex deposits. Although it is possible to obtain a detailed evaluation of the various constituents of the deposit, in most cases this is unnecessary. Instead, by means of simple field tests, the samples can be broadly classified on the basis of their solubility in the various commercial chemical solvents. These major classifications are as follows:

1—Acid solutions
2—Alkaline solutions
3—Hydrocarbon solvents
4—Chlorinated hydrocarbons
5—Oxidizing agents
6—Specialized solvents

Sub-classifications in any particular category can then be made on the basis of which specific solvent effects the most rapid yet economical removal of the deposit from the line. Thus, a major factor in determining the solubility of a deposit is its physical composition. If the material is homogeneous in form, its is simply a question of finding the best solvent to dissolve it. If, however, the deposit is a heterogenous agglomeration of particles, possibly it may be removed more economically by merely dissolving the binding material and flushing the disintegrated residue from the line.

In choosing the proper solvent, the factor of safety with respect to personnel and equipment must also be taken into consideration. Chemical inhibitors must be included in acid solvents to insure adequate protection of metal lines against acid attack.

Special precautions must be taken with lines constructed of certain corrosion-sensitive metals. Cast iron, for example, must be treated at lower temperatures than low-carbon steels. Some types of stainless steels require specially formulated solvents to avoid embrittlement of the metal. Acids or strong alkalies cannot be used in cleaning galvanized piping without sacrificing the galvanizing.

On the basis of the laboratory or field examination, definite recommendations are made regarding the composition, concentration and temperature of the solvent to be used. The chemical cleaning engineer then estimates the amount of deposit present in the line and the quantity of solvent required to accomplish its removal. Inlet and outlet connections are selected. Valves and connections already present in the lines usually are suitable for this purpose. Locations are chosen for vents, to release any gases evolved during the reaction between the deposit and the chemical solvent.

Inflammable or toxic gases must be vented to an open space where they can be released safely. In some instances smoking should be suspended and flames or "hot-work" prohibited in the vicinity of the cleaning operations. When hydrogen sulfide is produced by the reaction, gas masks and sometimes special gas scrubbers should be available. Proper safety clothing should be compulsory for all personnel handling acids, alkalies, inhibitors or other chemicals.

In most instances, removal of the deposit is obtained by filling the line with solvent and allowing it to soak long enough to dislodge or dissolve the deposit. The line is then flushed and neutralized and, when necessary, a passivating solution is introduced to protect the freshly cleaned surfaces from after-rusting.

In the case of more difficultly soluble deposits, it may be necessary to apply several different solvents either in combination or in separate stages. Continuous or intermittent circulation of the solvent is frequently used to speed up deposit removal. In the case of extremely recalcitrant deposits, mechanical cleaning aids are used in conjunction with the cleaning solutions.

Mechanical Aids

The use of auxiliary mechanical aids has broadened the scope of chemical cleaning applications to include many lines which otherwise could not have been cleaned by the "fill and soak" method. These mechanical aids, known familiarly as "pigs" and "moles," supplement the chemical action of the solvent with mechanical cutting action. This results in breaking loose the deposit from the line in sufficiently small chunks to be flushed readily from the line. This comparatively recent development has become increasingly popular, since in many cases the deposit removal is not only easier and faster but more economical as well.

Two major justifications for employing mechanical aids in the chemical cleaning of pipe are:

1—Piping layouts, which, for some

reason or other cannot be cleaned conventionally.

In some instances the deposit may prove to be only slightly affected by any of the commercially employed chemical solvents. A combination chemical-mechanical treatment often will remove the deposit, avoiding the necessity of line replacement.

In other cases, when deposits have built up until the line is completely blocked, the solvent cannot be brought into contact with all of the scale, requiring the use of mechanical aids. In still others, the design of the line itself is such that it is impractical to fill the pipe with solvent.

There also are cases where the line is constructed of material that cannot be adequately protected from attack by the cleaning solution. The only recourse, then, is to use mechanical aids when rapid deposit removal can be effected with a minimum of damage to the line.

2—Where the cost of the job will be materially reduced by their use. This is especially characteristic of large diameter lines, which would require large gallonages of solvent to fill them. The use of mechanical aids permits deposit removal with greatly reduced volumes of solvent. This also applies to soft or friable deposits which can be readily broken loose by the mechanical tool, but otherwise would require considerable quantities of solvent for their removal. In lines where the deposit is only slowly soluble, the cleaning process is greatly speeded up by employing these techniques.

Another valuable application is in cleaning lines while they are in operation. Many times, sewer lines carrying waste materials or cooling effluent cannot be taken out of service without shutting down the manufacturing process. By employing mechanical aids the plugging deposits can be removed without interrupting the normal flow of liquids through the line.

Two basic tools are used for this type of line cleaning. The first of these, the "pig," is fairly well known in the oil industry due to its extensive use in cleaning out oil-field transportation pipe-lines. It has been adapted, in modified form, for industrial cleaning operations in refineries and petrochemical plants.

Many designs of "pigs" have been developed for different applications. Basically, however, the "pig" consists of a series of wire brushes and scrapers, held by spring tension against the side of the line, followed by a rubber gasket or seal that fits snugly against the cleaned pipe. A typical example is shown in the photograph. This tool is placed in the line and fluid is pumped in behind it. The pressure of the fluid forces the "pig" through the line, mechanically scraping off the deposits before it.

In most cases, an opening in the "pig" permits a stream of the cleaning solution to spray ahead. This serves two functions: to wash the dislodged deposits out of the pipe, ahead of the "pig," thus preventing any possible build-up that might result in sticking the "pig" in the line; to react with the deposit, weakening or softening it, so that it may be more readily broken loose by the "pig." Frequently, a pre-treatment with solvent, followed by application of the "pig," will result in the easy removal of a deposit which otherwise would have been extremely difficult to dsilodge.

The "mole" is similar in principle, to the "pig," except that high-velocity fluid jets rather than metallic brushes or scrapers are utilized to remove the scale. Essentially, the "mole" consists of a jet nozzle, containing a number of restricted orifices, affixed to a heavy-duty, flexible hydraulic hose. Fluid is pumped through the hose under high pressure (1500 to 4000 psi), escaping through these orifices in high-velocity streams that impinge on the deposit with considerable force, cutting and breaking it apart.

As in the case of the "pigs," a number of different "moles" have been designed for various applications. A typical example is also illustrated.

It will be noted that the jet orifices angle backward. This results in a force that pushes the "mole" forward through the line, dragging the hydraulic hose after it. The speed of forward motion is controlled by the rate at which the hose is paid out at the point of introduction. The dislodged deposits, in this case are washed backwards, out of the pipe.

The size, shape, angle and number of orifices in the jet head may be varied, depending on the pipe size, hardness of scale, pressures employed, and other conditions of the treatment. In cases where the pipe is almost completely clogged, an additional orifice is set into the head of the tool to clear a hole through which the "mole" can burrow.

The choice of "pig" or "mole" depends largely on the particular application involved. Each tool has its own advantages and limitations which must be taken into consideration in planning a chemical cleaning treatment.

The "pig" is especially suited for extremely long lines, as it is introduced at one end of the line and travels, independently, to the other. The "mole," on the other hand, is limited to the length of the hydraulic hose following it. As a result, it is only suitable for short lengths of pipe, usually not more than 150 ft. The diameter of the pipe does not limit the use of either of these tools, except that if a line changes size a number of times, the "pig" cannot be used. Also, if restrictions or protruding connections are present in the line, the passage of the "pig" will be blocked. The "mole" is not affected by such partial obstructions.

In order to use a "pig," the line to be cleaned should be capable of withstanding at least 100 psi, as fluid pressures of this magnitude are usually required to force the "pig" through a scale of average hardness. There is no such limitation on the "mole," as the high fluid pressures employed are confined within the hydraulic hose, and the line itself is not subjected to any appreciable pressure.

If the scale deposit is too hard, the "pig" may stick when only partially through the line, and must be retrieved. A measuring line, fastened to the "pig," indicates its progress through the pipe line, and may be used to free the "pig," if necessary.

The presence of sharp bends or turns in a line may restrict the use of "pigs" and "moles." Under normal circumstances, these tools will navigate a 45° radius turn. If sharper turns are present, however, the forward motion of the tool is usually halted.

Bibliography

(1) "Three 'Musts' in Chemical Cleaning," by D. P. Thornton, Jr., PETROLEUM PROCESSING, March, 1954.

(2) "How Chemical Cleaning Makes Money," by J. T. Browning, *Petroleum Refiner*, February, 1954.

(3) "The How and When of Water Well Acidizing," by W. M. Zingg, *Plant Engineering*, August, 1953.

(4) "How to Clean Storage Tanks," by B. P. Robinson and E. W. Hudgens, *Petroleum Engineer*, April, 1953.

(5) "Chemical Cleaning of Refining Equipment," by Gerald L. Farrar, *Oil and Gas Journal*, March 23, 1953.

(6) "How to Clean Slurry Exchangers," by W. M. Zingg and B. P. Robinson, PETROLEUM PROCESSING, June, 1952.

(7) "Chemical Cleaning of Process Side Equipment," by C. H. Groom, *Petroleum Engineer*, May, 1950.

(8) "Chemical Cleaning in the Refinery," by C. H. Groom, *Petroleum Engineer*, April, 1948.

(9) "Chemical Removal of Scale from Water Lines," by R. Tunnell and J. T. Browning, *Southern Power and Industry*, November, 1947.

(10) "Chemical Cleaning Takes the Bull Work Out of Scale Removal," by E. W. Feller and G. F. Williams, *Power*, September and October, 1946.

42 Stockholder Companies Are in FRI

Anderson-Prichard Oil Corp.
Ashland Oil Refining Co.
Bechtel Corporation
C. F. Braun & Co.
Brown & Root, Inc.
Catalytic Construction Co.
The Chicago Corporation
Continental Oil Co.
Dresser Engineering Co.
Eastern States Petroleum Co.
El Dorado Refining Co.
El Paso Natural Gas Co.
The Fluor Corp., Ltd.
Gasoline Plant Construction Co.
Fritz W. Glitsch & Sons, Inc.
The Globe Oil & Refg. Co.,
Hudson Engineering Corp.
Husky Oil Company
Kendall Refining Co.
Kerr-McGee Oil Industries, Inc.
Keystone Oil Refining Co.
Koch Engineering Co.
Koppers Company, Inc.
Lone Star Producing Co.
The Lummus Company
Arthur G. McKee & Co.
The C. W. Nofsinger Co.
The Ohio Oil Company
Oriental Refining Co.
The Ralph M. Parsons Co.
The Pennzoil Company
Phillips Petroleum Co.
J. F. Pritchard & Co.
Rock Island Refining Corp.
Roosevelt Oil & Refining Corp.
The Stearns-Roger Mfg. Co.
Stratford Engineering Corp.
Sunray Oil Corporation
Taylor Oil & Gas Co.
Texas Engineers
Tide Water Associated Oil Co.
Warren Petroleum Corp.

Non-Profit Fractionation Research

New cooperative program is sponsored by 24 petroleum and 18 engineering firms

By D. P. THORNTON, Jr.
Southwestern Editor

THERE appears to be no way in the light of today's technical knowledge for the tower operator or his engineers to decide which design method is "right" or "best," or which is the optimum type of tower internals to use on a given job.

Methods now commonly employed in fractionation column design have proved unreliable in many cases, especially in the types and sizes generally required by the petroleum processing industries. Often, actual capacities have been found to be less than or more than design requirement, by as much as 200 to 300% for even the well-known bubble-cap tower.

This problem, then, is what caused a nucleus of 42 companies recently to become stockholders in a non-profit research organization, called "Fractionation Research, Inc.," with headquarters offices at Bartlesville, Okla. They are aiming at getting the best possible answers to all the current, plaguing questions about fractionation equipment. If they are successful, and there is every reason to expect it, the knowledge gained will quickly repay the individual company's cost of participation.

The idea of incorporating a cooperative organization of companies, and even individuals, to sponsor research in fractionation was pushed by T. B. Hudson, first of Phillips Petroleum Co. and now president of Fractionation Research, Inc. It was the natural outgrowth of his knowledge of "Drilling Research, Inc.," formed several years earlier to investigate drilling procedures and equipment in a program too expensive to justify itself for an individual petroleum company. After some "missionary work," financial backing was secured. The fractionation research company was incorporated April 4, 1952, under the laws of Delaware.

The too-high cost for a single company is the principal reason why private investigations have not been made long since. A number of companies are known to have instigated serious efforts to secure the necessary data to predict column vapor-liquid handling capacities and separation efficiencies

These Are the Men Who Run Fractionation Research, Inc.

T. B. Hudson President and chairman of the executive committee, FRI

G. H. Burruss Anderson-Prichard Oil Corp.; and vice president and a member of the executive committee, FRI

W.H.Humphreys Ashland Oil Co., and a member, FRI executive committee

W. W. Kraft The Lummus Co., and a member, FRI executive committee

R. E. Luton The Ohio Oil Co., and a member, FRI executive committee

C. E. Wharton Warren Petroleum Co., and a member, FRI executive committee

K. H. Hachmuth Phillips Petroleum Co., and chairman, FRI technical committee

under various loading conditions. But, in practically every case, completing the projects could not be justified as an individual enterprise because of the time and anticipated cost.

The story is told of the costs encountered by Drilling Research, Inc., also a cooperative venture, to illustrate the expensive nature of this type of investigation. Several years ago Drilling Research was formed to study ways and means for improving the drilling of holes in the earth. Various methods have been studied and this company has spent $1,250,000 in the past five years with a pay-off in promising results.

Few individual companies, indeed, could have afforded to risk either the time or more than $1,000,000 in investigations which, when started, held no guarantee of ever having commercial applications. The gamble is just too great. But, as stockholders in this venture, the cost to the individual company has probably been less than the expense of equipping, maintaining and paying one research engineer.

The need for accurate data on commercial scale distillation is greater than ever, if for no other reasons than because fabrication and installation expense have risen steadily while fractionation requirements have become more and more precise. Hence 24 (57%) of the 42 companies now stockholders of Fractionation Research, Inc., are *users* of fractionation equipment. Most of the remaining 18—nonusers—are engineering contractors who design and erect fractionators but do not fabricate them; the remaining firms are designers and fabricators or do all three.

Fractionation Research is by no means a "closed corporation." More stockholders are welcome. Each stockholder may own only one share of stock. There are big and little companies, Independents, and Majors.

Active efforts to secure more stockholders—there's room for 208—were temporarily halted shortly after FRI was incorporated April 4, 1952, with enough money paid in to start work without indebtedness. Now that "the show is on the road," worthwhile progress can be demonstrated to interest prospective stockholders in all categories. As of August 1, 1954, the company has spent about $300,000 in assembling a staff, investigating available knowledge on the subject and designing and building an experimental distillation column. In operating a "simulator column," significant knowledge already has been obtained about what goes on in a distillation column which either was previously unknown or imperfectly understood.

The research objective of FRI is stated as intending to develop the requisite information so that presently-operating equipment may be revamped for increased capacity, separating efficiency, or both, and new columns can be designed which will be less expensive, more effective, reliable and flexible than possible with today's knowledge of design.

The familiar bubble-cap tray design will not be the only type of column internals evaluated, but it will receive considerable emphasis because it is still the most common tray design found in modern fractionators. It might be expected that there already is ample information upon which to base bubble-cap designs because of their long time use.

However, a study of design methods now in use by companies considered to be highly experienced in distillation work indicates the converse is true. This showed that the several methods of computing the cross-sectional area of a column designed for a specific operation gave answers differing by 50 or even 100% between extremes. Even wider variations were encountered when sizing downcomers, or considering other details of column design.

The selection, evaluation and design of other types of fractionator trays present even more of a problem because relatively little information is available to guide either the designer or the operator. Perforated trays are a good, but not the only, example.

Although interest in perforated trays has been strongly renewed in the recent past, many operators are reluctant to use them because they believe that insufficient data are available to judge their operability. Others have not accepted them because of unfortunate previous experiences. Instead of the principles, perhaps the real culprit may have been poor design. The data which would permit choosing between the several perforated tray designs or between them and still other designs are not available.

There also are a number of other vapor-liquid contacting devices on the market today which are said to have better characteristics than bubble-cap trays. Fractionation Research regards some of these contactors as so promising that they offer the possibility of substantially reducing the investment required for new facilities or of increasing the output of existing units with a minimum of investment. However, FRI also believes that much work needs be done before the designer and operator can know when such devices, or which of them should be used and what really can be ex-

* NOTE: Pictures were not available at press time of: D. W. Wilson, Arthur G. McKee Co., and vice president, FRI; and J. W. Roach, Kerr-McGee Oil Industries, Inc., and a member FRI technical committee.

E. W. Volkmann Koppers Co., and vice-chairman, FRI technical committee

A. S. Brunjes The Lummus Co., and a member, FRI technical committee.

W. F. Fulton Warren Petroleum Co., and a member, FRI technical committee

C. W. Nofsinger C. W. Nofsinger Co., and a member, FRI technical committee

C. K. Viland Tide Water Associated Oil Co., and member, FRI technical committee

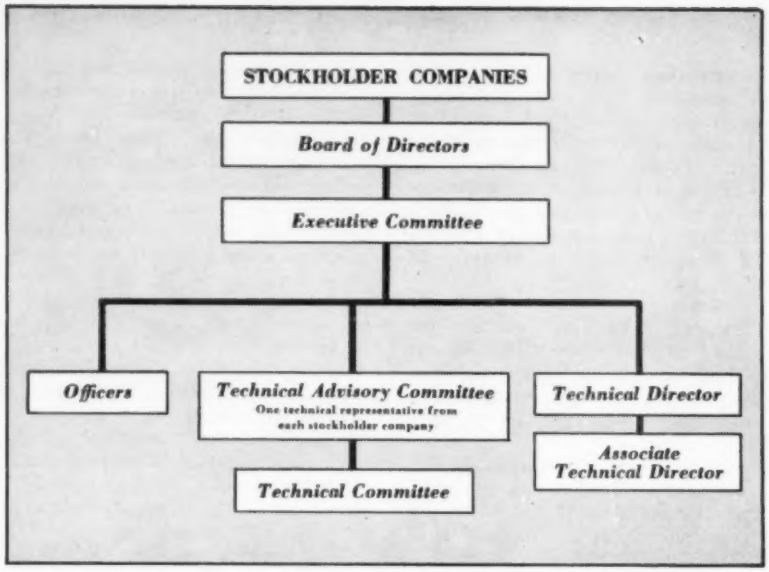
E. M. Amick, Jr. technical director, FRI

F. W. Winn assoc. technical director, FRI *

FRI Administrators

Technical director for Fractionation Research, Inc., is Erwin H. Amick, Jr. Associate technical director is Francis W. Winn.

Dr. Amick, most recently associate dean of engineering, Columbia University, was for a number of years process engineer with Standard Oil Development Co. Mr. Winn, most recently assistant chief process engineer, Catalytic Construction Co., also has been associated with Pan American Refining Co., Petroleum Administration for War, and Socony-Vacuum Oil Co., Inc. Both men have had extensive experience in design and research in the field of distillation.



ORGANIZATION CHART for Fractionation Research, Inc.

pected of them. Ultimately, most of these probably will be investigated.

Organization of FRI

"Fractionation Research, Inc.," is a non-profit Delaware corporation, formed specifically for "the conduct of research and development work covering methods and apparatus useful for, or necessary in, separating the components of a fluid of mixed composition on the basis of their relative volatilities or vapor pressures." Its $25,000 of authorized common stock (250 shares) is non-dividend bearing; there is no "preferred" stock.

Only one share of stock can be sold to or held by an individual, partnership or corporate entity, or to an individual connected with a stockholder or jointly-owned company. No affiliate or jointly-owned interest of a stockholder may own a share.

Each stockholder is entitled to elect just one member of the board of directors and one member of the technical advisory committee (this need not be the same individual). This last group is advisory to FRI's directors and officers on all technical matters, serves as the liaison between the stockholder a..d the technical director, and it supervises and reviews the efforts of the technical director.

The directors, in turn, elect the corporation's officers and from themselves select an executive committee of seven who conduct FRI's business affairs. The technical advisory committee also elects a seven-man technical committee from its members to conduct its affairs, subject to review by the general committee. All serve without compensation. A technical director and one or more assistants may be hired by the directors to actively supervise the actual research work, plus such other personnel as may be required.

The organization chart of FRI shows that although authority exists, a large research staff has not been built up for the work and this is not contemplated. Instead, an agreement has been made with C. F. Braun & Co., Alhambra, Calif. (a stockholder), to use its facilities and personnel as and when required, at hourly rates. This gives extreme flexibility without the expense of recruiting and maintaining a staff of specialists which might be needed only part-time.

Each stockholder must execute an agreement as a prerequisite to purchasing a share of stock. This agreement contains the above provisions, among others, and also calls for an underwriting contribution over a five-year period by the stockholder. The minimum total contribution is $5,000 and maximum $100,000, computed by an allocation factor. No more than 40% of this need be paid in any one year.

The allocation factor for an oil refiner is 50¢ per bbl. of the stockholder's daily crude throughput capacity as shown in Bureau of Mines Information Circular 7578 for January 1, 1950. For a natural gasoline manufacturer the factor is the natural gasoline capacity multiplied by 1¢ per gallon as disclosed in the Bureau's Information Circular 7576 for January 1, 1950. If the stockholder is both a natural gasoline manufacturer and refiner, the larger of the two operations is the determining factor. Capacity means its own as well as those of its "participating" affiliates and its fractional interests in similar operations of "participating" jointly-owned companies. Minority interests may be excluded, which exclusion also excludes knowledge or the use of any discoveries made by FRI.

A stockholder who is a non-operator of fractionating equipment is measured by a different but comparable yardstick for his five-year contribution. Here the criterion is net assets as disclosed by the annual statement for 1949 or sworn net worth as of January 1, 1950. The allocation factor is 50¢ per $1000 of assets.

Other interesting provisions in the agreement include the following:

A stockholder does not grant to FRI any rights in discoveries or patents past, present or future, purchased or developed by its own research and by its affiliates. It is never obligated to disclose to FRI any of its technical information.

Each stockholder will receive all technical information and data developed by FRI which, in turn, may be communicated to stockholder's "participating" affiliates, and to its employees and independent contractors who agree to keep such disclosures confidential.

Each stockholder is granted an irrevocable, non-exclusive, royalty-free immunity from suit for infringement under each patent at any time owned by FRI during the period until the stockholder relationship with FRI ceases. This is extended to stockholder's "participating" affiliates, but may not be assigned unless the assignee

agrees to be bound by the agreement with FRI.

FRI may license the results of its work and sell requisite technical information to other than stockholders for a reasonable royalty. The income received shall be used to reduce the total net expenses of FRI and thus stockholder underwriting.

When FRI is liquidated (it now is set up to exist for five years from September 30, 1952, but the time can be extended), its assets other than patent rights are to be distributed to the stockholders in an amount not to exceed the total of the stockholder's expense contributions and value of capital stock investment. Any excess assets are to be given to one or more non-profit educational institutions, to be selected by the directors.

The stockholders shall determine at the time of liquidation what disposition other than by assignment to any or all stockholders shall be made of patent rights. If no agreement is reached the patent rights shall be dedicated to the public.

Provisions also are contained covering the sale of all or part of a stockholder's manufacturing business to another or in the event stockholder is purchased by another.

The Research Program

Three important preliminaries already have been completed.

The first was a literature search of the field of fractionation by Midwest Research Institute, Kansas City, Mo. A final report has been distributed which summarizes each article and is indexed by subject and author.

The second was a patent search. A report giving the results of this search was distributed recently.

The third preliminary consisted of conferences with research institutes, universities, oil and chemical firms, and engineering firms. They were asked to contribute their experience in designing, fabricating and operating fractionating equipment and for their recommendations in conductng the research.

The research will involve three principal phases. They are: 1) investigations by means of a "simulator" column of various distillation devices, starting first with bubble-cap trays; 2) study of the devices indicated by "simulator" tests as worthwhile in an "experimental column" of commercial diameter; and 3) full-scale tests with actual plant columns to check and extend the data secured from the experimental column or perhaps from the simulator also.

Studies in commercial size equipment will be made but are not limited to the following:

1. Evaluating standard designs of fractionation equipment.
2. Optimum tray spacing.
3. Maximum practical length of liquid path.
4. Optimum depth of liquid on the tray.
5. Optimum slot velocity.
6. Optimum vapor and liquid flow rates per unit of cross-sectional area.
7. Preferred bubble-cap shape and arrangement.
8. Improved downcomer design.
9. Effect of pressure on fractionating column performance.
10. Effect of viscosity of liquid phase on performance of the fractionating column.
11. Effect of surface tension of the liquid phase on column performance.
12. Effect of liquid and vapor densities on column performance.
13. Other factors affecting hydraulics and mechanical performance of the fractionating column.
14. If necessary to find optimum design factors, determination of the effects of solubility, diffusion rate and relative volatilities on the rate of material transfer between the phases.

The simulator column, privately built by C. F. Braun & Co., Alhambra, Calif., several years ago to aid in experimental designs of distillation equipment, is shown schematically in an accompanying sketch. It consists of a three-tray, 5-ft. 6-in. column in which can be circulated such gases as air, CO_2, and natural gas at rates up to 16,000 cfm., and water, kerosine, gas, oil and other non-corrosive liquids at rates up to 550 gpm. It is provided with large sight ports for observation of downcomers and trays from the sides and top, and internal lighting to permit moving and still-picture studies of operations.

The simulator column will be used as a "screening device" for bubble-cap trays and other contacting devices before trying them in the "big" experimental distillation unit. Operation of the experimental distillation unit will be expensive and time-consuming. Only those designs which show promise of having some characteristic which will give them an advantage over the known trays will be investigated in the large column.

It will be possible to obtain much more information with the simulator than is usually the case on the effect of the properties of the gas and liquid, since most other simulators do not have provision for gas recirculation. This limits such simulators to the use of air and also places restrictions on the liquids which can be employed.

Pressure drop, entrainment, hydraulic gradient, vapor and liquid distribution, flood point and "tray activity" will be measured. The latter is merely a visual rating. The effect of liquid and vapor properties on these characteristics will be investigated. Even so, the simulator data cannot be considered too final because it is limited to low density conditions and it is difficult to obtain data on the amount of material being transferred from one phase to another.

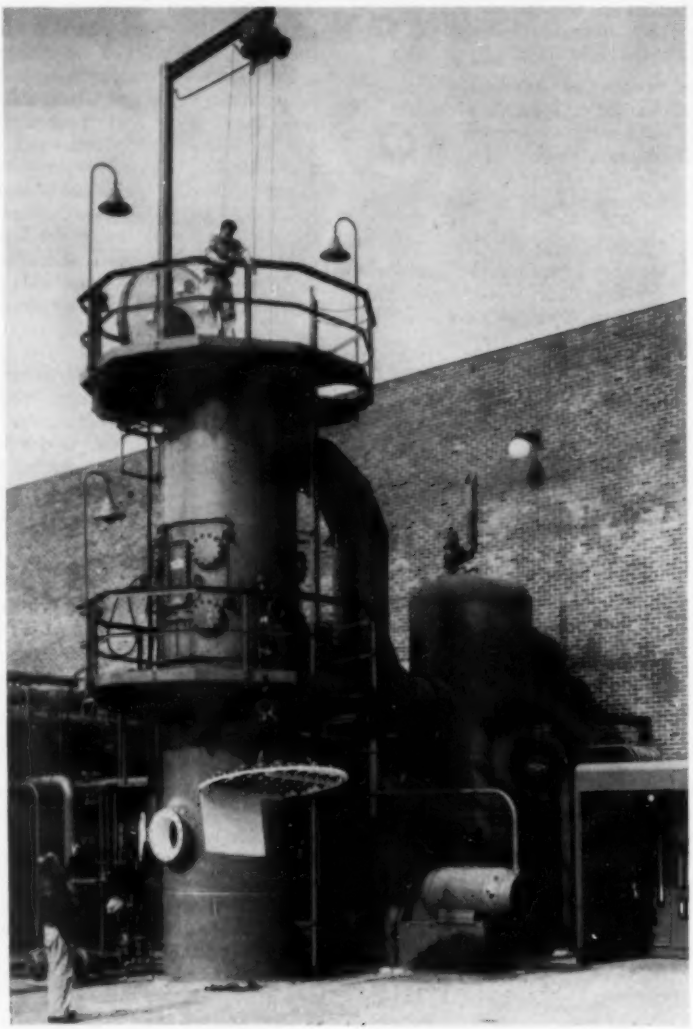
The experimental distillation column is now nearing completion at Braun's, Alhambra, Calif., plant and will be located adjacent to the simulator column already in use by FRI. Completion was scheduled by August 1 and it will have been placed in operation shortly thereafter.

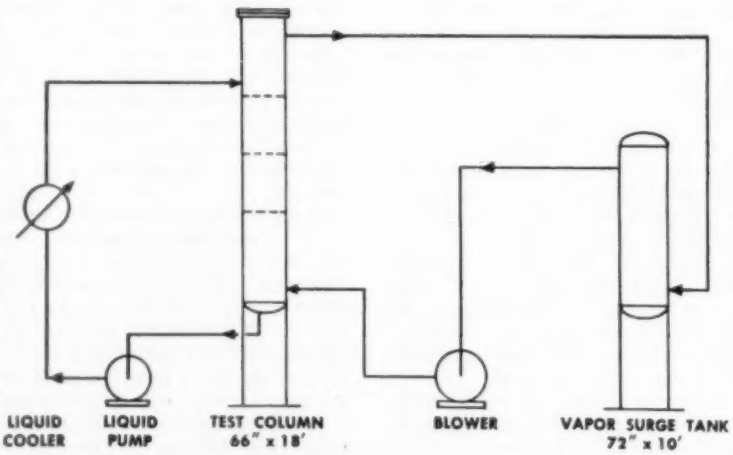
The experimental column is 4 ft. inside diameter by 40 ft. high and will be capable of holding 10 trays on 24-in. spacing. It is designed for operation at pressures ranging from atmospheric to 150 psig., and ultimate operation as low as 5 mm. Hg absolute.

At the level of Tray 4, four nozzles, 90° apart, have been provided in which windows will be installed; 7⅜ in. diameter for low pressure work and 4 in. for the higher pressures. A large window has been installed in the downcomer to permit observation through the windows and this will allow measurement of the levels of liquid and froth in the downcomer. Tray 4 always will be installed to permit detailed observation through the windows.

Two nozzles have been installed in the top head of the column so that the top tray also can be observed. The top head is removable so that tray rings can be inserted or removed and likewise complete trays as a unit. Sample points and thermocouple wells are located every 6 in. along the shell to permit determination of plate temperatures and compositions at all tray spacings.

Every effort has been made to develop an assembly of internals which will permit tray spacing to be changed with a minimum of problems and still allow changes of entire trays or parts with the least difficulty. In a tower of this diameter, it is especially important to keep the tray support ring narrow to prevent it from occupying too high a percentage of the tower cross-sectional area. The tray ring used is 1¾ in. wide. The rings are sealed to the tower with asbestos-rope packing compressed by a packing ring.





FIRST STEPS in fractionation research will take place in this "simulator" unit, which is designed to "screen out" some ideas before tryouts in the larger unit

A "clean shell" type of construction has been employed. Trays will be supported on adjustable rods which rest on a support welded into the column above the reboiler vapor nozzle. These adjustable rods permit the trays to be spaced as desired between 12 and 36 in. and are the means of leveling the trays.

The trays have been made up in three separate sections to allow changes in tray construction to be made cheaply and easily. These consist of a downcomer section, a downcomer seal section and a contacting section. In the contacting section will be installed the bubble-caps, perforated plates, etc., to be studied. With this construction it will be easy to study various contacting devices merely by lifting out one contacting section and substituting another. This also will permit using the same downcomer and downcomer seal sections in studying the different contacting devices.

A schematic flowsheet of this unit and its auxiliaries is shown in an accompanying drawing. This does not include the vacuum equipment, which will be added later along with required modifications. It will be noted that both the reboiler (heated by 200 psi steam) and the condenser are rated for 15 million Btu., considerably greater than used in normal practice for a tower of this size. However, in testing contacting devices to their ultimate capacity under a wide variety of conditions, some having much more capacity than bubble-cap trays as they are known today may be encountered.

Overhead and bottoms streams will be recycled to minimize storage requirements for feed and products. The unit can be operated as a stripping, enriching or conventional fractionation unit. Products are withdrawn by level controllers in accumulator and reboiler. Tower pressure is controlled in effect by regulating the amount of heat transfer surface in the overhead condenser by means of a level controller on the condenser which is reset by a pressure controller on the column.

The first studies will be on bubble-cap and perforated plate trays; the former because of their wide-spread use and the latter because of their promise. Moreover, reliable information on the capabilities of a well-designed bubble-cap tray are needed as a "standard" against which other types of trays can be compared.

After these studies are completed, investigation of other types of contacting devices will be made. Such devices as the "Turbogrid," Koch "Kaskade" and "Benturi" trays,

Socony-Vacuum "Uniflux" tray, the Nutter "Float-Valve" tray, the Kittel Tray and "Panapak" have been suggested.

Several systems will be used initially in testing the trays. FRI believes that sufficient information will be secured about the effects on system properties by such factors as liquid and vapor handling capacity, froth height, downcomer build-up and column pressure drop that subsequent work can be simplified by tests with just one or two systems; i.e. a tray can be adequately characterized for other systems via correlations which will have been developed.

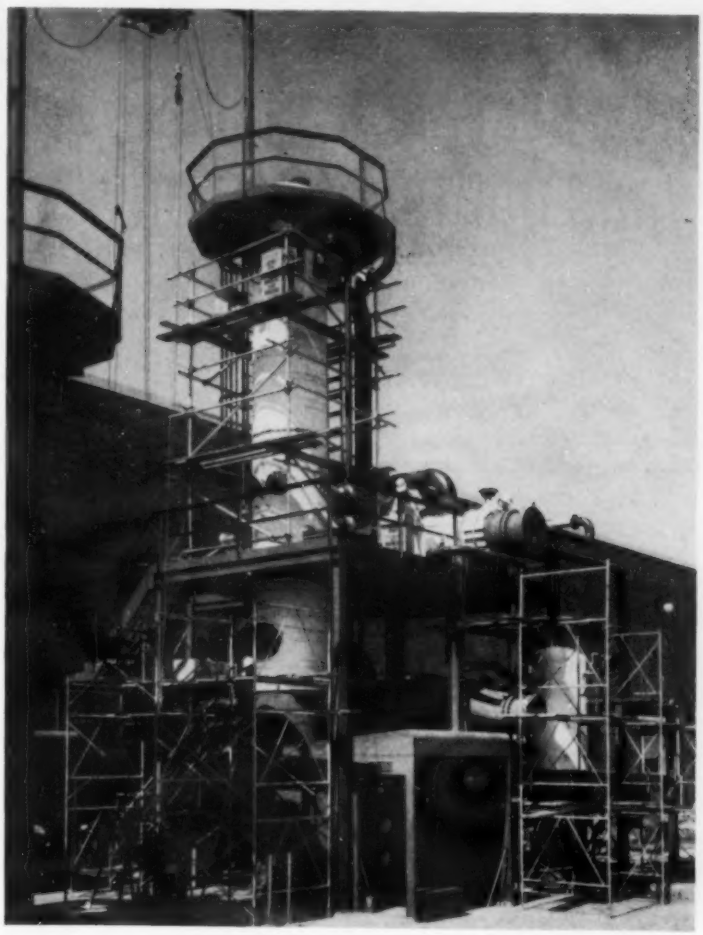
The American Institute of Chemical Engineers is sponsoring a research program on distillation also, and FRI has contributed to the support of this work. The AIChE efforts will be confined primarily to the determination of the effects of system properties on plate efficiencies using, at least for the present, columns of 2-ft diameter or less. FRI expects the AIChE program to supplement its own work in this field.

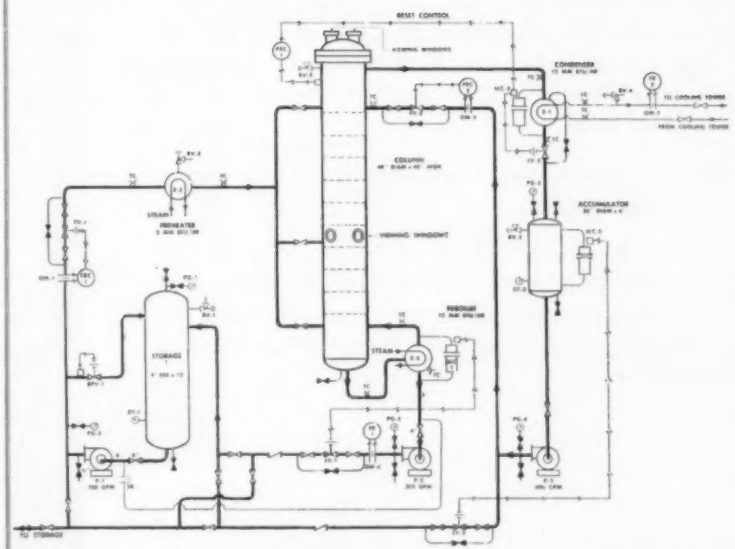
Runs on the first few trays will be comprehensive. These will include runs at various constant pressure with values of reflux ratio (L/V) ranging from 0.5 to 1.5. At each of these, tray efficiency at 40, 65 and 90% of the flooding capacity will be determined.

Typical of the systems to be used will be: normal and isobutane, methylcyclohexane-normal heptane, isopropyl alcohol-water, methyl ethyl ketone-sec. butyl alcohol and hexane-absorption oil. Binary systems ordinarily will be used because analysis is simple and more reliable. Sufficient work will be done with ternary and multicomponent mixtures, however, to assure no doubts as to the applicability of results to these more complex systems.

Actual plant tests will be made as the third phase of the program. Here, using columns which have been voluntarily offered for the work by a number of stockholder companies, capacity and efficiency tests of commercial fractionators and absorbers will be made. These data will be used to check the results of the experimental program and provide added data on systems which cannot be run in the experimental unit.

It will not be possible, for instance, to make either very high pressure absorption or fractionation tests with the experimental unit. But, with the large number of commercial columns which have been offered, it will be possible to select for these tests those columns which will provide the maximum of usable information.





SECOND STEP in fractionation research will involve exhaustive tests on this large-scale experimental distillation column, shown in the photo under construction

ETHYL RESEARCH BUILDS A "WHIRLING PIN CUSHION"

to probe the secrets of combustion deposits

A special whirling disk developed by Ethyl research people may help technologists come up with the answer to one of the "hottest" problems facing the petroleum and automotive industries.

The problem: Exactly what can be done about the deposits that build up in the combustion chamber of a modern gasoline engine?

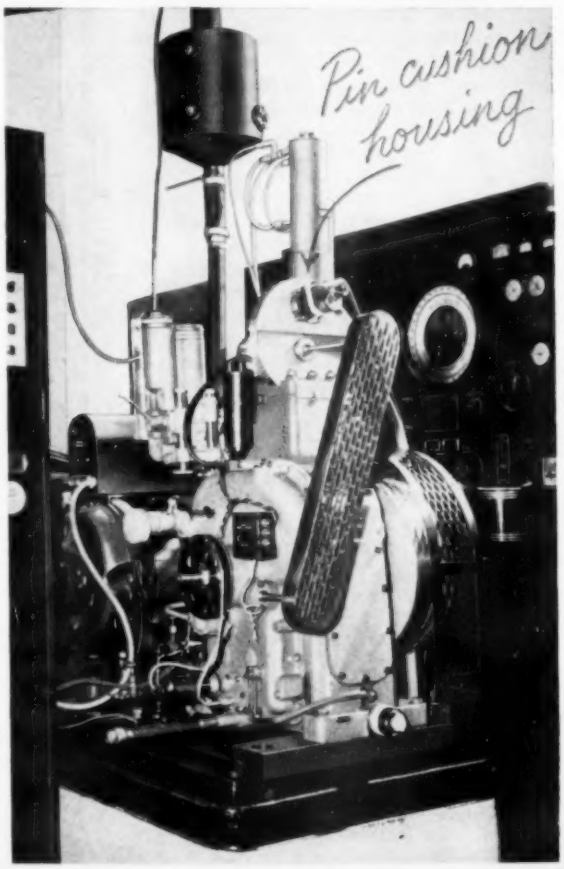
Only when researchers can understand what they are and how they form through the interaction of fuels, oils, additives and the metals of the engine, will it be possible to render these deposits harmless.

Ethyl research people have been at work on the problem for years and in many different ways. Recently, they made another step forward when they developed an amazingly simple test instrument they affectionately call the "whirling pin cushion."

By spinning the pin cushion in a special test rig, researchers are now able, for the first time, to trace the step-by-step formation of combustion products—at all phases of the cycle.

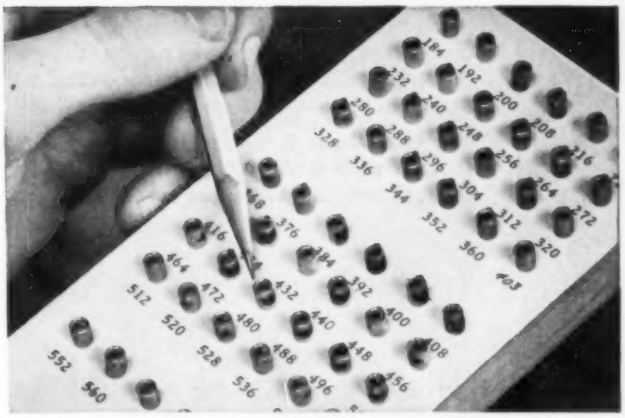
This is another milestone in basic research on combustion-chamber deposits.

New test instruments at Ethyl Laboratories like the "whirling pin cushion" are helping us piece together the fundamental knowledge which will eventually open the door to engines and fuels of far greater efficiency than are possible today.



Special test engine synchronizes the "whirling pin cushion" with the engine cycle so that each pin picks up deposits from exactly the same portion of the cycle each time.

Sampling "pins" on Ethyl's "whirling pin cushion" move past a specially constructed opening in the cylinder head of a test engine and pick up combustion deposits—as they are being formed.

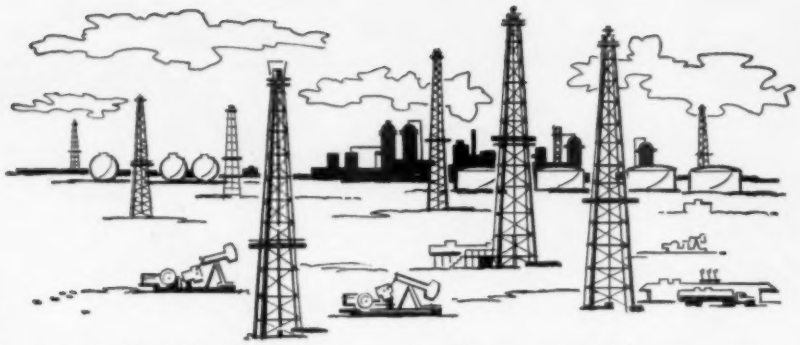


Each pin on the disk accumulates deposits formed.

Ethyl laboratories "fingerprint" the deposit on each sampling "pin" by X-ray diffraction.

ETHYL CORPORATION
Research Laboratories

1600 West Eight Mile Road, Ferndale 20, Michigan
2600 Cajon Road, San Bernardino, California

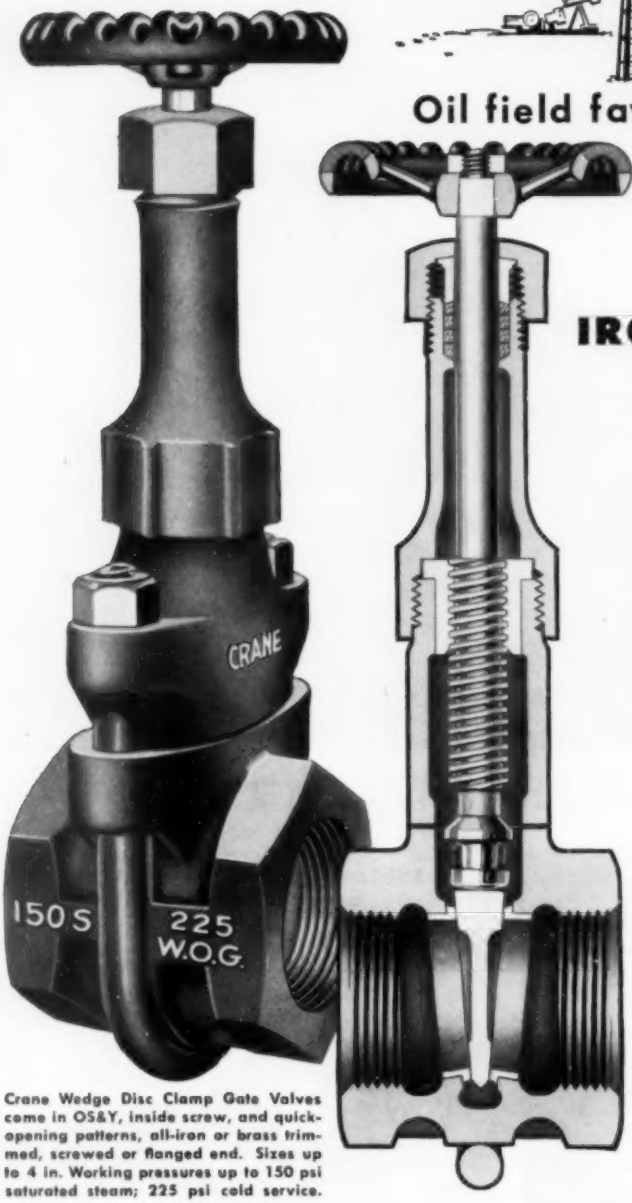


Oil field favorites...for **good** reasons

CRANE

IRON BODY—WEDGE DISC

clamp gates



Crane Wedge Disc Clamp Gate Valves come in OS&Y, inside screw, and quick-opening patterns, all-iron or brass trimmed, screwed or flanged end. Sizes up to 4 in. Working pressures up to 150 psi saturated steam; 225 psi cold service.

Versatile valves—excellent for crude, fuel, and lubricating oil—for air, gas, and gasoline. And use them too for steam, hot and cold water . . . even for corrosive chemicals and gasses. Your choice of regular patterns, all-iron or brass trimmed.

Dependable valves—because they're extra rugged, with a strong, reinforced body and husky stem. On inside screw all-iron valves, an improved self-draining bonnet prevents entrapment of line fluids in the bonnet—protects the threads, keeps the stem working smoothly.

Economical valves—not only in first cost, but in upkeep as well. Their compact design means a better fit for more places . . . a saving on piping in many cases. Simplified clamp construction makes quick work of normal maintenance—ideal where frequent cleanout is essential.

Ask your Crane Representative for Folder AD 1667, or write direct. Find out for yourself why Crane Clamp Gate Valves are the oil field favorite!

THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

PETROLEUM PROCESSING

SEPTEMBER 1954

Petrochemical Processing Section

IN THIS SECTION

What's the Big Picture?

The overall status of the petrochemical industry today — p. 1381

and a look at its potential for tomorrow — p. 1384

And then the Details

Six articles on the outlook for six groups of products —synthetic rubber, detergents, plastics, sulfur, carbon black, and fertilizers — p. 1387

The Petrochemical Industry

Your 1954 Directory

$555,000,000 worth of new plants now planned or building in U.S. and Canada, bringing total to 322 plants operated by 176 companies . . . . . p. 1417

In the Departments

Solution to a problem in the measurement and control of a corrosive hydrogen chloride stream — (Plant Practices) p. 1435

Partial oxidation process is useful for making acetylene from hydrocarbons — (Patents) p. 1439

OTHER DEPARTMENTS

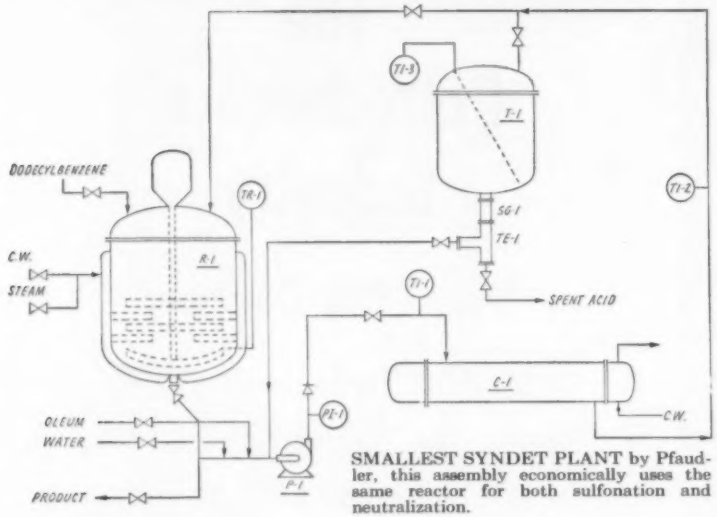
Personals 1468
Suppliers 1469
Books 1488
Meetings 1459
Information Offered 1462
Advertisers' Index 1464
What's New! 1468
Editorials 1496

Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N. Y.

Junior-Sized Synthetic Detergent Plant Permits Experimental or Small-Scale Production



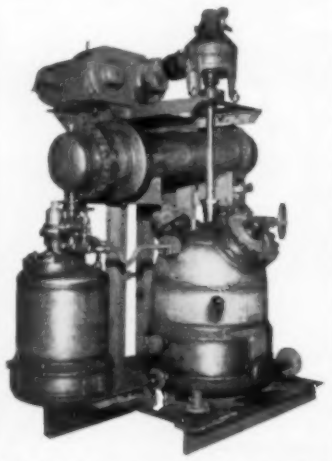
SMALLEST SYNDET PLANT by Pfaudler, this assembly economically uses the same reactor for both sulfonation and neutralization.

To meet the growing demand for a small-scale alkyl aryl detergent plant, Pfaudler now offers a complete pilot plant, priced less than $8,000.

You get every basic part, including piping, fittings, and instruments. No welding is required on the piping.

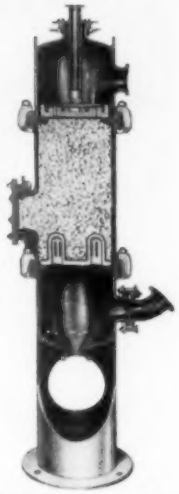
All items are glassed or stainless steel. This system will produce up to 400 lbs. of finished detergent slurry in an 8-10 hour day. With the addition of a second reactor, semi-works production is possible, producing about 2,000 lbs. of high active detergent slurry in a 24-hour operating day.

Many plants are now saving money by producing their own detergent. Perhaps this low-cost "all-in-one" plant is the most convenient way for you to begin this practice. Write us today for further details.



INCONEL was used in this assembly for solvent recovery. See article (right).

First Column Ever To Have a Family!



They said it couldn't be done. They said every glassed steel column had to be a custom job, built to meet the customer's special requirements.

But Pfaudler wondered about that. Wondered why all these "special" features couldn't be included as standard. Wondered if a standard design wouldn't cut the cost, speed the delivery, increase the flexibility of Pfaudler glassed steel columns.

Out of all this pondering came the new *standard* family of glassed steel columns, first in the world. From the 2-inch (diameter) "baby" column to the 48-inch "grandaddy" tower, in any desired length, you can now expect fast delivery, and the flexibility of standardized components. Yet you still get the corrosion resistance and working strength of glassed steel!

For more information about *standard* glassed steel columns, write us today.

Super Market for Chemical Equipment

Vast choice of materials gives corrosioneers a free hand in solving your process problem.

Besides stainless steel and glassed steel, Pfaudler corrosioneers have a complete selection of alloys to use in solving process equipment problems.

Hastelloy, monel, nickel, inconel, aluminum, titanium—through experience with hundreds of corrosion applications, Pfaudler knows just which alloy will best suit each situation. You can be sure of exactly the material of construction that will do the job best, because Pfaudler has no "favorite sons."

If you've a process equipment problem involving corrosion, contact your Pfaudler representative for an unbiased analysis of your needs or drop us a line today.

PETROCHEMICALS' ROLE IN THE CHEMICAL PICTURE

	OUTPUT billions of dollars			VALUE billions of dollars		
	1953	1952	% Change	1953	1952	% Change
ALIPHATICS	16.2	14.3	+13%	2.4	2.2	+9%
AROMATICS	2.2	1.7	+29%	0.4	0.3	+33%
INORGANICS	6.9	5.4	+29%	0.2	0.2	....
TOTAL PETROCHEMICALS	25.3	21.4	+18%	3.0	2.7	+11%
ALL CHEMICALS	114.3	100.4	+14%	6.14	5.38	+14%
PETROCHEMICALS as a % of all CHEMICALS	22%	21.4%	+3%	49%	50%	−2%

Petrochemicals-TODAY

HERE ARE THE HIGHLIGHTS of the current picture for petrochemicals:

- **OUTPUT in 1953 was at a greatly accelerated rate over 1952, reflecting the completion of new plants in the national defense program.**
- **RATE OF EXPANSION has temporarily overbuilt plant capacity on a few of the large volume products.**
- **GREATER VOLUME OUTPUT has moved more petrochemicals into the select group where shipments are in "tank car" quantities.**
- **PRICES of many petrochemicals intermediates have come down as a result of competition and improved processing methods, even though prices for raw materials, both petroleum and natural gas, increased moderately in 1953.**

PETROCHEMICAL manufacturing—that lusty offspring resulting from the alliance of the petroleum and chemical industries—is still putting on weight like you'd expect any healthy youngster to put on weight.

Total 1953 output of petrochemicals in the U. S. was 25.3 billion pounds, largest on record and 18% greater than the 1952 output, reflecting the completion of new plants in the national defense program. The rate of growth in output in 1952 was 6%.

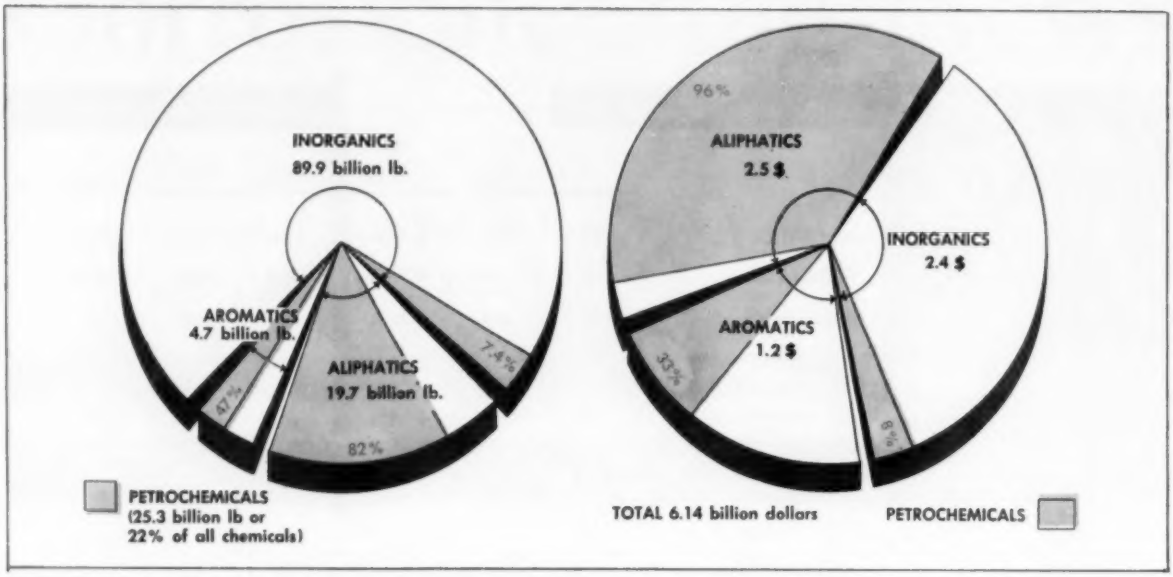
In setting the 1953 record the petrochemical industry maintained its overall rate of growth since the war. Its rate of increase in production in 1953 was over three times that for the conventional petroleum products, such as motor fuel and heating oils.

Reduced to barrels, the oil man's common denominator, the 1953 petrochemical output was around 85,000,000 bbls. Small potatoes, volume wise, compared with straight petroleum products. Because of their much higher prices, however, the petrochemical sales of a few oil companies in 1953 were 12 to 15% of their total sales, though made from less than 2% of the crude they processed.

The 1953 petrochemical output included 16.2 billion lbs. of aliphatics, 13% greater than in 1952.

While only 2.2 billion lbs. of aromatic petrochemicals were turned out in 1953, the rate of gain from the year before was 29%. This reflected the increased capacity in catalytic reforming units which the oil companies have installed the past few years. Some of these turn out benzene, toluene and xylene, as well as high octane motor fuel components.

Output in 1953 of the inorganic petrochemicals (ammonia, carbon black and sulfur, principally) was 6.9 billion lbs., also a gain of about 29% from the year before. Increased manufacture of ammonia from natural gas for making fertilizer accounts for the large gain.



PRODUCTION of all chemicals produced in the U. S. in 1953—of which 22% were of petrochemical origin

VALUE of all chemicals produced in the U. S. in 1953—to a total of $6.14 billion

The production of 25.3 billion lbs. of petrochemicals in 1953 was 22% of the U. S. production of 114.3 billion lbs. of all chemicals. In 1952 the proportion of petrochemicals was 21.4% of a total output of 100.4 billion lbs.

Of the 19.7 billion lbs. of aliphatic chemicals made in the U. S. in 1953, 82% were petrochemicals, about the same proportion as in 1952. Of the 4.7 billion lb. of aromatics, 47% were petrochemicals as against 40% in 1952. Of the 89.9 billion lbs. of inorganic chemicals, a very small proportion, 7.4%, was petrochemicals, compared with 7% in 1952.

The above data on chemicals output was supplied PETROLEUM PROCESSING by Dr. R. L. Bateman, Manager of Fine Chemicals, Carbide and Carbon Chemicals Co., and are a projection of a study made about a year ago. The statistics on petrochemicals cover the field of intermediates, between the crudes, such as ethylene and benzene, and the finished products, plastics, synthetic rubber and so on. The same carbon atom is counted only once in progressing from the crude starting material to the final intermediate product. The U. S. Tariff Commission report for 1953, reviewed in the July issue of PETROLEUM PROCESSING, covered only the primary petrochemicals where used for further processing into intermediates.

The value of petrochemicals produced in 1953 was $3 billion, of a total of $6.14 billion for all chemicals produced in the U. S., a gain of $300 million from 1952. The petrochemicals' $3 billion in 1953 included $2.4 billion value for the aliphatics, $400 million for aromatics and $200 million for inorganics.

The average sales price of aliphatic petrochemicals in 1953 was 15¢ a lb., the same as the year before; of aromatic slightly under 19¢ a lb., while in 1952 it was 19¢; of inorganics 2.7¢, while in 1952 it was 2.5¢ a lb.

The investment in petrochemical plants, both those of oil companies and chemical concerns, at the end of 1953 was over $3 billion. This was 11% larger than the $2.7 billion plant investment for 1952. This estimate is based on the assumption that something over $1 in plant facilities is required for $1 in annual sales—a yardstick for plant investment used by the chemical industry. With the cost of plant facilities built in 1954 or projected for this year, as surveyed by PETROLEUM PROCESSING and reported on pg. 1417 in this issue, the total capital investment in the petrochemical industry by the end of this year will be approximately $3.35 billion.

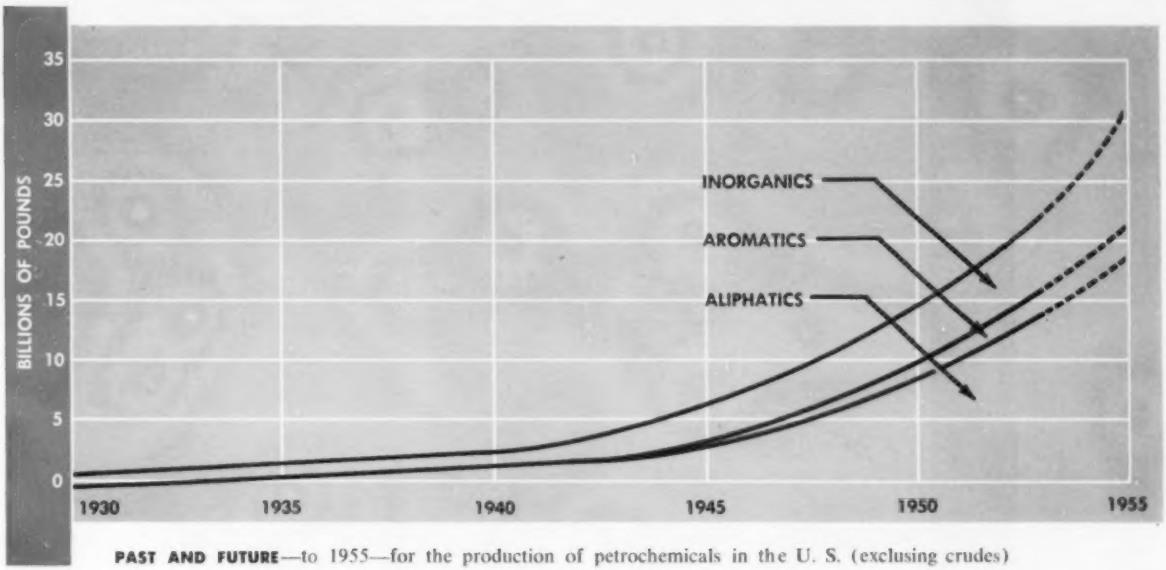
Using the same $1 of sales yardstick, the 1953 capital investment in the chemicals manufacturing industry was around $6.15 billions, not including that in plants turning chemicals into final end products.

Over production of some products in the petrochemical line has resulted from the general large expansion of plant facilities in the postwar years. This situation has been intensified under the Office of Defense Mobilization program, which had for its goal building up surplus standby capacity available to turn out the required volumes of essential war materials in the day of need. As in the petroleum refining industry the excess plant capacity for petrochemicals has not been altogether regarded as standby for emergency use. In a number of basic petrochemicals there is evidence of capacity to produce being temporarily ahead of market requirements. Examples of a few such petrochemicals are:

Ethyl Alcohol: Before World War II, 21% was synthesized from petroleum materials, 72% came from molasses and the rest from grain. Now the ratio is around 63-32 in favor of the synthetic product. U. S. capacity for the synthetic product will be 230,000,000 gals. by the end of 1954, which is just about what total needs will be. During the Korean war consumption reached 344,000,000 gals. annually. The price then was 90¢ a gal., but has since dropped to below 35¢/gal.

Ethylene Glycol: The supply situation has changed greatly since the early months of the Korean war, when permanent anti-freeze was hard to supply. Now manufacturers are offering inducements to dealers to stock up on supplies, to get away from using the word "permanent" and to talk about changing automobile cooling systems periodically. The coming market for anti-freeze is estimated at 110,000,000 gals., much less than the available supply. The price has dropped from 16 to 11¢ per lb.

Phthalic Anhydride: Production capacity in 1951 was 227,700,000 lbs. a year. The ODM set a goal, including



PAST AND FUTURE—to 1955—for the production of petrochemicals in the U. S. (exclusing crudes)

emergency needs, of 367,000,000 lbs. production capacity. Now there is talk of production reaching 340,000,000 lbs., with not that much demand in sight.

Benzene: Production for chemical conversion, excluding motor grade, jumped from 255,730,000 lbs. in 1952 to 462,105,000 lbs. in 1953, a gain of 81%. Potential supply is tremendous, from the refiners' catalytic reforming units. The price has dropped from 55¢ to under 40¢ per gal. and supplies are such that some of the chemical grade is being dumped into motor fuel.

Methanol: Another billion-pound chemical, used principally in processing formaldehyde, increased in production from 1.100 billion lbs. in 1952 to 1.115 in 1953. Its price range over a few years has been from 40¢ per gal. to 27¢.

Offsetting overbuilt plant capacity, many petrochemicals in 1953 moved into the select "tank car" class. As new markets were found for them, their production reached toward hundreds of millions of pounds annually, high enough that shipments are in the volumes that refiners are accustomed to handle with petroleum products. Thus the term "tank car trade." Such shipments of liquids run from 5000 to 10,000 gals. Solids shipped in from 30,000 to 50,000 lbs. lots are also considered in this classification.

The use of petrochemicals as gasoline additives provides recent examples of how new markets move specific items into volume business. Tricresyl phosphate, an end product including a petrochemical, was used to the extent of about 15,000,000 lbs. a year until Shell Oil Co. discovered its properties as a gasoline additive and dramatized it as TCP. Now it is in the large volume group. The Texas Co. built a special processing unit at its Port Arthur refinery to make the petrochemical additive "Petrox" for its premium gasoline.

Decylalcohol and tridecylalcohol are two new products of Esso Standard Oil Co., made at the Baton Rouge refinery, which moved into the tank car class in 1953. The former is used as a plasticizer and the latter in making synthetic rubber.

An alkylated substituted aromatic, given the trade name of Ionol, was developed by Shell Chemical in 1953 as an anti-oxidant to prevent rancidity in foods of fats and oils. Without the aid of an advertising and promotion program, its volume has reached the point it is now shipped in tank cars.

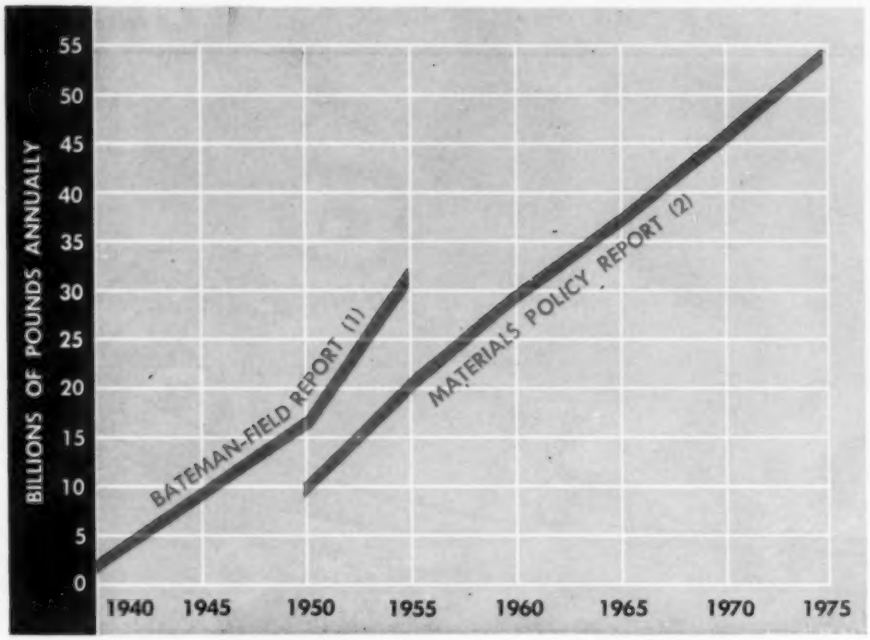
Two other examples of new petrochemicals moving into volume output in 1953, with further growth anticipated, are: Acetonitrile, stemming from acetic acid and ammonia, and produced by Carbide and Carbon Chemicals Corp., is used as a solvent and an intermediate in the manufacture of drugs; Isocyanates, developed by Monsanto Chemical and du Pont from petroleum, are finding volume markets as resins and in making new types of synthetic rubber.

Prices for the raw materials for petrochemicals trended upwards in 1953, reflecting the prices for crude petroleum in the oil fields and for natural gas at the wellhead. In spite of these changes, prices for some crude petrochemicals dropped during the year, due to the general abundance of refined products and natural gas liquids. Also, noted above, prices for some intermediate petrochemicals dropped, due to competition for the markets and lower manufacturing costs through improved manufacturing techniques.

The average price for crude oil in the fields went up from 6.1¢ in 1952 to 6.5¢ in 1953. Projected new chemical plants in the southwest were running into prices of 15¢ per Mcf. and higher at the wellhead for natural gas in the Texas fields, while a few years ago gas could be bought on long term contracts at 6 to 7¢/Mcf.

On the Gulf Coast, liquefied petroleum gas for conversion into petrochemicals sold FOB refinery or gasoline plant at an average price of 4¢ per gal, against 4.37¢ in 1952. In New York and Philadelphia harbors the average price was 8.2¢ per gal., against 7.7¢ in 1952.

Current changes in prices for the raw materials for petrochemical manufacture, and those for many years to come, will in no wise reflect any change in the supply available for this use. Despite the increases from year to year in the volume of petrochemicals produced, only about 1% of the crude produced in the U. S. today goes into this usage. The ethylene produced from natural gas today is estimated to be only 3.8% of the potential ethylene (ethane) recoverable from gas that could be used for chemical manufacture. And petroleum can also be used to produce ethylene.



THE OUTPUT TREND is sharply upward for petrochemical intermediates, regardless of what authority you use

Petrochemicals-TOMORROW

- Output will continue to grow—but at a slower pace
- Oil will tend to replace gas as raw material
- Late starters like acetylene will come up fast
- More oil company petrochemicals will be "captive"

MANY developments taking place in the petrochemical field today are significant in that they indicate likely trends in the course of that industry in the years ahead. Some of these pointers toward the future are:

- The volume of petrochemicals produced in the U. S. will continue to grow at a good clip, but not as fast as in the 1950-1955 period. The proportion of all chemicals made from petroleum and gas, rather than from other sources, will also continue to increase.
- Petroleum will trend toward replacing natural gas as raw material for the manufacture of some petrochemicals.
- Some late starters among the volume petrochemicals will take the spotlight in the next year or so.
- Increasing numbers and volumes of petrochemicals will be "captive" products, i.e., used by the oil companies making them in improving their own petroleum products.

Outlook through 1955: Total U. S. petrochemical production in 1955 will be 31.5 billion pounds, an average increase of 12% each year for 1954 and 1955. This is a somewhat slower rate of growth than the 18% for the industry in 1953 and more in line with the average annual gain in output of 14% from 1950 through 1953.

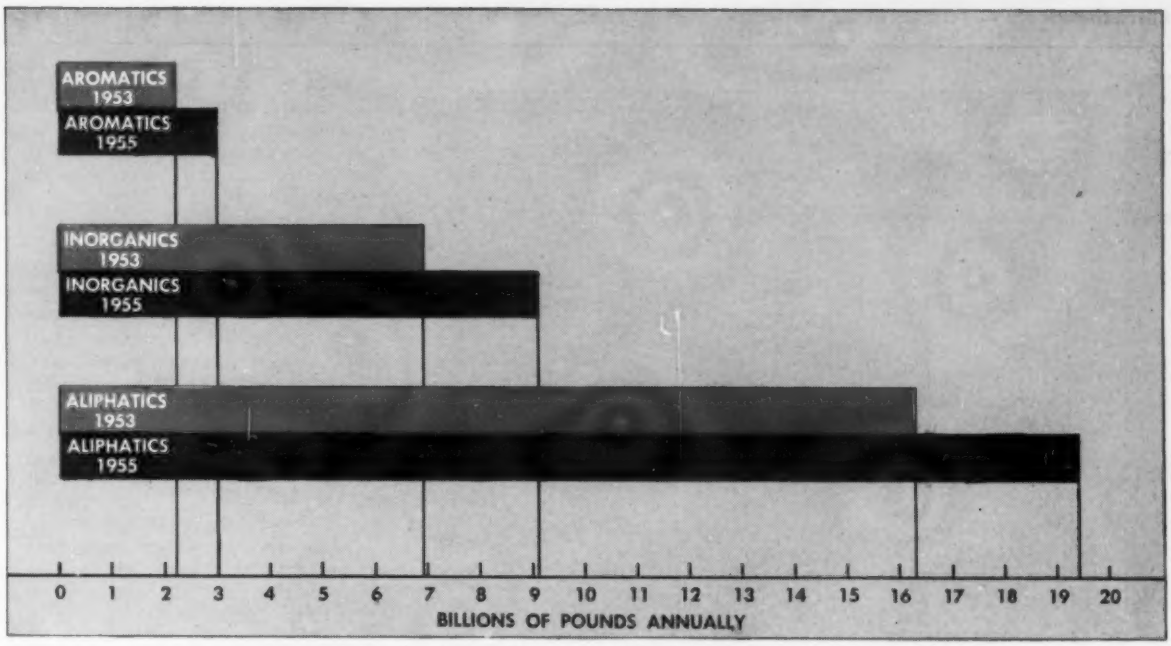
The output of aliphatic petrochemicals in 1955 will be 19.4 billion pounds, an average annual gain this year and next of 10% from the 1953 production of 16.2 billion pounds and about in line with the rate of gain since 1950.

The volume of aromatic petrochemicals produced in 1955 will be 3.0 billion pounds, an average annual gain in output of 18% for 1954 and 1955. This is the highest rate of gain estimated for the three groups of petrochemicals during this two-year period. It reflects the continued expanding use of the oil companies' catalytic reforming units for making benzene, toluene and xylene.

The output of inorganic petrochemicals in 1955 will be 9.1 billion pounds, a rate of growth of 16% annually for this year and next. The high rate of gain from the 1953 production of 6.9 billion pounds will be due chiefly to the new ammonia from natural gas plants now completed or in course of construction.

The data for 1955 output is based on a study of the petrochemical markets made by Dr. R. L. Bateman, Manager Fine Chemicals, Carbide and Carbon Chemicals Corp.[1] His figures deal largely with the intermediates, i.e. those undergoing processing in the stage between the crude petrochemicals and the finished petrochemical product.

"By 1955 the petrochemicals industry will occupy even a larger proportion of the entire chemical industry than it now does," said Dr. Bateman,


AROMATICS 1953
AROMATICS 1955
INORGANICS 1953
INORGANICS 1955
ALIPHATICS 1953
ALIPHATICS 1955
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
BILLIONS OF POUNDS ANNUALLY

GETTING SPECIFIC, here's how Bateman and Field break down their forecast[1] for 1955 output as compared with 1953's

"and by that time should have $4 billions invested in plants producing petrochemicals with a value of $4 billions."

By 1965 the petrochemical industry will be supplying 50% of our total chemical needs, Dr. Bateman believes, as compared with a little less than 25% today. Dr. Wayne E. Kuhn, Manager of the Technical and Research Division, The Texas Co., believes that by 1962 the proportion of 50% of all chemicals from petrochemicals will be reached and that the industry then will "begin to assume its permanent position in the expanding field of synthetic chemicals."

Long range outlook: For estimates of the production and requirements in petrochemicals beyond 1955, both the chemical and petroleum industries use the data presented in the 1952 report of the President's Materials Policy Commission, specifically the chapter on Forecasts for Petroleum Chemicals in Vol. IV, titled the "Promise of Technology."[2] This report was prepared by the Standard Oil Development Co.

Starting with 1950 the SOD report presents data on the end-use requirements of primary petrochemical products and projects the data at 5-year intervals through 1975, as shown on the chart on pg. 1384. Dr. Bateman's data on petrochemical output is also shown, for 1940 through 1955. The variance in the output figures shown for 1950 and 1955 is due in part to the fact they were made by two competent authorities working independently, but chiefly to the fact Dr. Bateman had the advantage of factual data about three years later than that available to the SOD estimators on which to base his figures. Despite the differences in the yearly output figures, the trend lines of the two sets of data are closely parallel and indicate the growth of the petrochemical industry in the two decades ahead will not slacken greatly from that experienced from 1940 to the present time.

Various authorities emphasize that a potential intruder in the petrochemical industry lurks in the years ahead; namely, the production of chemicals by the hydrogenation of coal. The best insurance against this contingency, since ample supplies of both natural gas and petroleum are available for whatever requirements may arise, will be the continuance of stable markets for petrochemical products, with prices maintained at a level where it will not be economically practical for other sources for petrochemicals to be developed.

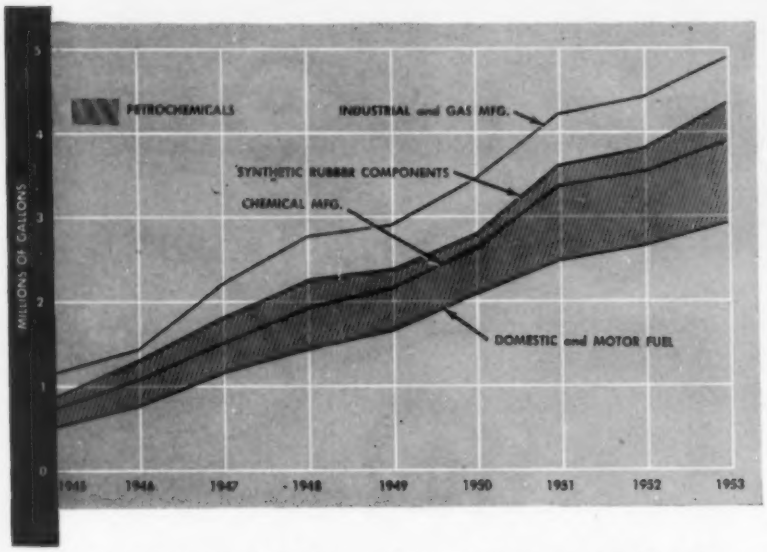
In the raw material picture, natural gas is already being replaced by petroleum fractions for the manufacture of some petrochemicals due to the increasing costs of gas at the wellhead and of transportation. The particular petrochemicals that will be affected are those where the cost of the raw material for processing is a relatively large part of the total cost of manufacture. Authorities say it will be uneconomic to pay 20¢ per Mcf. for gas to make some items, while manufacturers of other products could pay out on 40¢ gas. Only in the case of a few specialized petrochemical operations is there any saleable residue gas left after the processing operation, as is the case with natural gasoline and cycling plants.

Many of the large petrochemical plants on the Gulf Coast are now paying from 14 to 14.95¢/Mcf. for their gas, while the average price in 1953 was 14.17¢ and in 1952 it was 13.19¢. One known contract price is 20¢/Mcf. at the wellhead, with an escalator

Primary Petrochemical Requirements by End Uses, 1955-1975[3]

(Millions pounds annually)

End Use	1955	1960	1965	1970	1975
1—Synthetic fibers	1,530	1,820	2,100	2,470	2,740
2—Synthetic rubbers	2,290	2,600	2,960	3,180	3,510
3—Plastics and plasticizers	4,510	9,450	14,460	19,320	24,670
4—Protective coatings	1,180	1,560	1,870	2,230	2,590
5—Automotive chemicals	2,180	2,550	2,890	3,150	3,400
6—Nitrogen products	2,720	4,210	5,370	6,500	7,670
7—Detergents	660	830	940	1,060	1,100
8—Miscellaneous	5,170	6,220	6,880	7,700	8,500
Total Primary Products	20,240	29,240	37,470	45,610	54,180



LPG AS A RAW MATERIAL for the manufacture of petrochemicals and for other uses (data from Bureau of Mines and Phillips Petroleum Co.)

clause calling for 0.4¢ more per year for 20 years. One Gulf Coast authority feels that 20¢ will be about the top price natural gas on the Gulf Coast can command without meeting heavy competition from coal. There are some old 4 and 6¢/Mcf. contracts for gas in effect in this area but they are being dropped as fast as possible.

A wellhead price of 25¢/Mcf. is the point at which conversion to other materials as feed stocks for some petrochemicals will start in earnest, in the opinion of Herman W. Zabel, executive vice president, Technical and Economic Services, Inc. Coke, coal, liquid petroleum fractions and other raw materials become competitive with natural gas at about this price, he says.

"At the moment it is less costly to manufacture ammonia from natural gas in all parts of the U. S.," he recently told an American Chemical Society audience. "However, it is extremely questionable whether this situation will persist over the life of an ammonia synthesis unit. Our studies indicate that in a period of 10 to 15 years ammonia producers in many sections will find it prudent to shift back to coal."

In the production of carbon black, where cost of the raw material is a large factor in the product cost, the transition from gas burners to a furnace black process using a petroleum fraction is already under way. By 1955, it is estimated half the carbon black produced will be from oil and the amount made from gas will decline rapidly after that. The present yield is 3 pounds per gallon of oil and this is being improved.

Other straws in the wind on the shift from natural gas to oil: Texaco Development Co.'s process using natural gas for conversion into carbon monoxide and hydrogen, which is installled in many ammonia plants, has been adapted to the use of heavy fuel oil in place of gas. At least two ammonia plants now building are to use oil. Allied Chemical & Dye Corp. has perfected its pilot plant work on the manufacture of ethylene by cracking heavy fuel oil and its Semet-Solvay Division is now using this process for making ethylene at its new Tonawanda, N. Y. chemical plant.

One of the "dark horses" among the petrochemicals as to large volume production is acetylene from natural gas, and the experience of the American Cyanamid plant near New Orleans, which was completed early this year, will help to establish its position as a competitor with acetylene from calcium carbide. Acetylene is in demand as a raw material for vinyl chloride and acetate and neoprene rubber, and new large markets are opening for its use for the manufacture of acrylonitrile which in turn is used to make synthetic fibers.

Even wider uses await the lower cost acetylene believed available from hydrocarbon sources as compared with that by the established calcium carbide route. Demand for acetylene for chemical manufacturing is now approaching 500 million pounds annually and is expected to be 700-750 million pounds by 1960. New production up to 1955 will be half from hydrocarbon sources and by 1975 it is believed that two-thirds of the acetylene production will be from natural gas or petroleum sources.

The acetylene synthesis at the new American Cyanamid plant involves an adaptation of a German process whereby oxygen and methane are separately heated, then mixed and passed through burners of special design. The yield is controlled by the close proportioning of the oxygen with the methane gas, by a very short residence time and by rapid quench to below the acetylene decomposition temperature. It is claimed that the acetylene so made, after purification, is equivalent in quality to the calcium carbide product.

Ammonia is another dark horse among the present large volume petrochemicals in that the extent of its growth in output the next year or so depends on how far the U. S. farmers go in applying nitrogen fertilizers to their soil. At present they are using half the amount the Department of Agriculture recommends. From a capacity of 1,291,000 short tons in 1951, ammonia production from all sources has increased to the point it is expected to top 3,200,000 tons in 1955. Recently the government raised its sights for nitrogen production, proposing a new goal of 3,500,000 tons by Jan. 1, 1957.

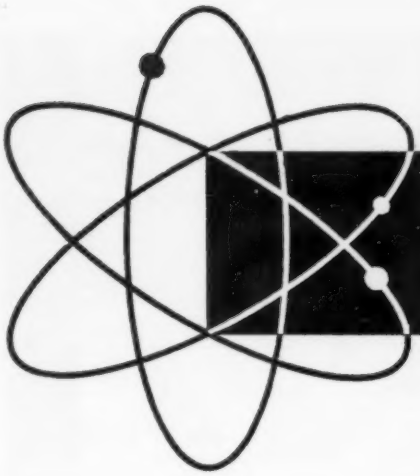
So-called "captive" petrochemicals will grow in number and volume as the oil companies making them find enlarged uses for them in their own products. Sulfonates, both alkyl and alkyl-aryl types, have been made by some oil companies for years as bases for the detergents they manufacture. The use of these materials is expected to grow.

More recently, the growing use of additives in motor fuels and lubricants has stimulated the production of the additive materials, or some of the components, in oil company petrochemical plants. Synthetic-engine oils, some components of which are petrochemicals, are being developed to meet the more severe operating conditions of today, particularly in jet engines.

References

(1) "The Scope and Growth of the Petrochemical Industry," R. L. Bateman and F. A. Field, Carbide and Carbon Chemicals Co.; presented before the Division of Petroleum Chemistry, American Chemical Society, Chicago, Sept. 9, 1953.

(2) "Forecasts for Petroleum Chemicals," Chapter 14, The Promise of Technology, Vol. IV, Resources for Freedom; Report by President's Materials Policy Commission, June, 1952.



PETROCHEMICALS — TOMORROW

The Outlook for . . .

Synthetic Rubber **1388**

By John T. Cox, Jr., Cox & Weinrich, Consulting Chemical Engineers, Washington

Synthetic Detergents **1392**

By Foster Dee Snell, Foster D. Snell, Inc., New York

Plastics **1395**

By Peter W. Sherwood, Chemical Engineer, White Plains, New York

Sulfur **1404**

By Norman C. Updegraff, Asst. Technical Director, The Girdler Co., Louisville, Kentucky

Fertilizer **1407**

By W. R. Allstetter, Vice President, and E. C. Kapusta, Chemical Engineer, National Fertilizer Assn., Washington

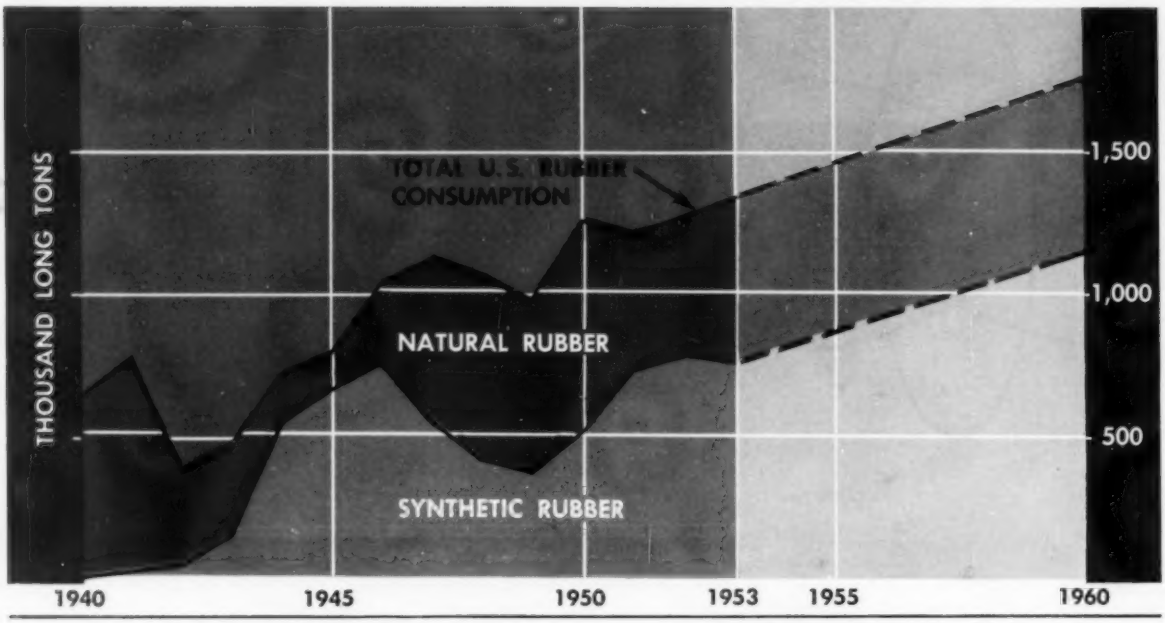
Carbon Black **1410**

By Alan F. Beede, Director, and C. A. Stokes, Director of Research and Development, Godfrey L. Cabot, Inc., Boston, Massachusetts

ON the following 29 pages are six feature articles, each one dealing with the current outlook for a specific petrochemical end-product or group of end-products.

When the authors were given the assignments of writing these articles for PETROLEUM PROCESSING they were asked to concentrate on the "futures" of their particular products. They were asked to consider three angles: (1) markets—what are the outlooks both for increasing present markets and for developing new ones? (2) technology—what changes are taking place in the way of processing which might alter the picture? (3) competition —what new sources of raw materials or new products are on the horizon which might threaten the present market outlook?

The six subjects covered here by no means comprise the entire field of petrochemicals. They are, however, representative of the various groups into which the bulk of petrochemicals can be classified—ranging from a single large-volume product such as carbon black to the field of plastics and its multitudinous uses for petrochemicals as intermediates. Together they give you a comprehensive picture of what the future holds for petrochemicals.



U. S. RUBBER CONSUMPTION—synthetic, natural and total, 1940 to 1953, with estimates to 1960

PETROCHEMICALS — TOMORROW

The Outlook for...

Synthetic Rubber

By JOHN T. COX, JR.
Cox & Weinrich
Consulting Chemical Engineers
Washington, D. C.

SYNTHETIC rubber as a major factor in the transportation field came into being in 1942 with the inception of large scale production of butadiene-styrene polymers by the U. S. Government. This was a war emergency measure designed to stopgap the cessation of natural rubber importations from the Far East. Since that time synthetic rubber has occupied a position of great importance in the overall consumption pattern of the U. S. and as a market for petrochemicals.

By 1960 the world consumption of new rubber should be at the annual rate of 3 to 3.3 million tons. The minimum estimate of U. S. consumption of this total is in the vicinity of 1.6 million tons. It is not expected, and this is thoroughly verified by the world rubber economists, that natural rubber will provide more than 1.7 million tons of the world's rubber needs.

We are faced, then, with the problem of providing the difference in the form of synthetic rubber in tonnages ranging from 1.3 million tons to 1.6 million tons. The present low cost capacity for synthetic rubbers in the U. S. is around 850,000 long tons per annum. The U. S. produces, as far as is known, over 90% of the world's synthetic rubber. We have, looking down our economic throats, the problem of providing 500-600,000 additional tons of synthetic rubber capacity by 1960, or much sooner, if the Far Eastern natural rubber supply declines or possibly vanishes entirely, due to emergency measures.

Insofar as technology is concerned, we do not have any immediate picture of rapid change confronting us. The major portion of the cost of the principal synthetic rubber, GR-S, is taken up in the cost of its petrochemical constituents, butadiene and styrene. The cost of putting these two components together now ranges from 3.8¢ to 5¢ per pound, and cannot be relieved by any foreseeable drastic technology. Any cost improvement will be in fractions of a cent.

The yields of butadiene from petroleum feed stocks used in its manufacture range as follows: from butane, 50-55%; from butylene, 68-70%. There has been little research on improving these yields in the past 10 years and such improvement would lower costs considerably.

Originally, we manufactured styrene from coke oven benzene and ethylene derived from alcohol dehydration. The petroleum industry quickly found cheaper ethylene by cracking propane.

The coke oven benzene monopoly has now been broken by the introduction of petroleum-derived benzene installations in many parts of the country, and we are no longer dependent on the rate of steel production to provide adequate supplies of benzene. Another potential factor in this monomeric supply will be the introduction of vinyl toluene, which has possibilities of being manufactured at a slightly lower cost than the straight styrene. However, the future of coal hydrogenation with respect to the production of benzene will tend to minimize the importance of petroleum as a source of the prime aromatic.

The competitive aspects of natural vs. synthetic rubbers have been the subject of many studies, and the technology of application of synthetic rubbers has come along at a breath-taking rate in its 12 years of existence. It has totally displaced the use of natural rubber for inner tubes. It can be used up to 95% in passenger automobile tires. It can be used in numerous applications of agricultural tires. At present it cannot quite meet the service demanded in heavy duty bus and truck tires, but the advancing technology promises to have this problem in hand during the next five years.

Overall we must look at the continued rise in rubber use. In 1930 this country used 375,000 long tons; in 1940, 650,000 tons; in 1949, 990,000 tons, and in 1953, the record total of 1,300,000 tons. It is expected that the growth of the demand between 1949 and 1960 will be in the vicinity of 62%. Tires, tubes and other rubber products used on automotive bus and truck vehicles account for 75% of rubber consumption.

A variety of synthetic elastomers have been developed over a period of two decades. The prime one, of course, is GR-S, composed of butadiene and styrene. Polymerized by emulsion catalysts their roots are well based in the petrochemical field, having as raw materials butane, butylene, petroleum benzene, propane and alcohol. Butadiene especially can come from a variety of petroleum sources. There are plants in existence today that produce this great building block from butane, normal butylenes and ethyl alcohol. The initial large amounts of butadiene were supplied from alcohol-butadiene plants, whose firm source of supply was from fermentation of agricultural products. These plants produce the highest cost butadiene due to the fact that the yields from alcohol are approximately 2.2 lb. per gallon of 190 proof spirits. A fairly accurate estimate of the cost of alcohol-butadiene may be arrived at in the following manner:

(cost of alcohol in ¢/gal. + 5) ÷ 2.2 = cost of butadiene in ¢/lb.

Alcohol has some violent fluctuations in price, ranging from nearly a dollar a gallon down to its present price of about 30¢.

Butyl-rubber is a totally petroleum-based polymer whose principal use at the present time is in automotive inner tubes. It is manufactured in two plants in the U. S. whose combined capacity is in the order of 90-100,000 tons per annum. It is composed approximately of 98.5% isobutylene and 1.5% isoprene, which are mass polymerized at —150° F. The isobutylene is extracted from catalytic cracker stocks and the isoprene is extracted from steam cracked naphthas. This polymer has a potential of expanding into other fields now occupied by natural rubber and GR-S. Its potential has not been fully explored and the rubber industry awaits with interest to see its exploitation in private hands.

The principal technology involved in the preparation of GR-S rubbers is the emulsion polymerization of butadiene and styrene in large glass-lined vessels. Initially this was carried out as a batch process, but later the large vessels were connected into a series and continuous polymerization has become the order of the day. The newest technology of the emulsion polymerization process involves the use of a series of pipes rather than the existing series of interconnected vessels.

Some studies have been made of the process using mass polymerization, that is, without emulsification of the principal components, and the resulting polymers do not have to go through a drying process. However, this technique is in its infancy and not yet in a stage of commercial success.

Mass polymerization is currently used in the preparation of butyl rubber, which is conducted at very low temperatures in reactors surrounded with boiling ethylene. One of the problems of the butyl rubber plant is the continuous purification of this ethylene to ensure a good boiling point to maintain the 150° F. necessary to keep the polymerization of isoprene and isobutylene within the prescribed balance limits.

Polymerization plants of the future can very well be fitted into the existing framework of the present copolymer plants, and the technological change can be carried out over a number of years.

What will be the effect of the disposal of the government owned industry to private enterprise? Almost all authorities agree that this move will be a most salubrious factor in the synthetic rubber world, and, for that matter, in the national economy. For one thing, it should encourage greater development of the industry.

The twelve years of research that have accompanied the government synthetic rubber program have been carried out under government auspices in colleges, universities, research institutes and among the major rubber companies themselves. Research conducted without the profit motive does not produce the same results that one expects

---

Meet the Author

John T. Cox, Jr. is a member of the firm of consulting engineers of Cox & Weinrich, in Washington, D.C. He has had extensive experience in the field of rubber, and in synthetic rubber in particular. He was active in the design and erection of the first standard GR-S plants, and later operated one of the largest. He was loaned to the Government by the Firestone Tire & Rubber Co. in 1944, and became deputy director of the Office of Rubber Reserve, which had charge of producing all of the synthetic rubber in the U.S. He terminated his Government services in January of 1950 and went into consulting practice. He was joined this year by Mr. Whitney Weinrich and they are specializing in petrochemicals, rubber and atomic energy processes.

Dr. Cox is a member of the American Institute of Chemical Engineers, the American Chemical Society, the Society of Plastic Engineers, The Rubber Division of the American Chemical Society, the National Association of Professional Engineers, The American Geographical Society, The Chemist Club of New York, and the University Club of Washington, D. C. He is married, has two sons, and claims to be a rum drinking Episcopalian.

Government-Owned Synthetic Rubber Facilities in the U. S.

Operator	Location	Capacity*
BUTADIENE PLANTS — PETROLEUM		
Cities Service Refining Corp.	Lake Charles, La.	60,000
Copolymer Corp.	Baton Rouge, La.	23,000
Humble Oil & Refining Co.	Baytown, Texas	49,000
Neches Butane Products Co.	Port Neches, Texas	197,000
Phillips Chemical Co.	Borger, Texas	71,200
Sinclair Rubber, Inc.	Houston, Texas	78,000
Shell Chemical Corp.	Los Angeles, Calif.	61,000
Standard Oil Co. of Calif.	El Segundo, Calif.	**
Total Petroleum Butadiene Capacity		539,200
BUTADIENE PLANTS — ALCOHOL		
Union Carbide & Carbon Corp.	Louisville, Ky.	87,000
Koppers Co., Inc.	Kobuta, Pa.	128,000
Total Alcohol Butadiene Capacity		215,000
STYRENE PLANTS		
Dow Chemical Co.	Los Angeles, Calif.	57,000
COPOLYMER PLANTS — GR-S		
Copolymer Corp.	Baton Rouge, La.	49,000
Firestone Tire & Rubber Co.	Akron, Ohio	30,000
Firestone Tire & Rubber Co.	Lake Charles, La.	99,600
General Tire & Rubber Co.	Baytown, Texas	44,000
B. F. Goodrich Co.	Port Neches, Texas	90,000
B. F. Goodrich Co.	Institute, W. Va.	122,000
Goodyear Synthetic Rubber Corp.	Akron, Ohio	15,200
Goodyear Synthetic Rubber Corp.	Houston, Texas	99,600
Kentucky Synthetic Rubber Corp.	Louisville, Ky.	44,000
Midland Rubber Co.	Los Angeles, Calif.	89,000
Phillips Chemical Co.	Borger, Texas	66,000
U. S. Rubber Co.	Naugatuck, Conn.	22,200
U. S. Rubber Co.	Port Neches, Texas	89,400
Total GR-S Copolymer Capacity		860,000
BUTYL PLANTS—GR-I		
Humble Oil & Refining Co.	Baytown, Texas	43,000
Esso Standard Oil Co.	Baton Rouge, La.	47,000
Total Butyl Capacity		90,000

* Capacity figures are maximum annual capacities as reported in 1953 by the Reconstruction Finance Corp., and are in terms of short tons for butadiene and styrene, long tons for the rubbers.

** The El Segundo butadiene plant supplies crude butadiene to Shell Chemical Corp. for purification along with Shell's crude butadiene. The El Segundo capacity is included in the capacity shown for the Shell-operated plant.

from a research program in any large private enterprise, although the government program has assembled a great many basic facts that will be valuable to a future program of privately conducted research.

It must be said at this time, however, that there are at least two things that have come out of government research in the last ten years that have had a great influence on the technology of synthetic rubber uses. I refer specifically to cold rubber; i.e., rubber whose polymerization has been conducted at temperatures in the vicinity of 40° F., and to the oil extended rubbers.

Low temperature GR-S polymerization produced a synthetic rubber that was *more than competitive* with natural rubber in its application for passenger automotive tires. Its immediate success led to the installation of large refrigeration units in almost all of the existing copolymer plants of the country. However, there is still a very large demand for the "hot" rubbers with which the program originally started. The same low temperature polymerization technique applied to the production of latices has given us a synthetic latex that is competitive in many respects to natural rubber latex. This, in turn, has given us a greatly expanded foam sponge industry.

The government research brought forward and put into production a new variety of synthetic polymers known as oil extended rubbers. Certain napthenic oils are emulsified and mixed with the copolymers while they are still in the latex form previous to coagulation to solid rubber. The resulting mixture is simultaneously coagulated and ratios of 100 parts of rubber to approximately 37 parts of oil are present in the finished product. A surprising thing now occurs, for the oil, instead of being treated or accounted for as "oil" in rubber compounding, is now treated as rubber hydrocarbon and the constituents and other ingredients are added to the raw oil rubber mix as if it were indeed all rubber hydrocarbon.

This development has led to a tremendous lowering of cost per pound of rubber hydrocarbon and has given a large boost to the productive capacity of the existing copolymer plants. There is little added capital needed for equipment, and a very small additional cost is added to the processing charge. Straight GR-S may sell for 23¢ a pound, but a pound of oil extended rubber using the same GR-S as a base and containing 37% oil, sells for approximately 18¢.

Output of oil extended rubbers has increased rapidly from the date of

their first production in 1951 to the first half of 1954, when it reached 31.2% of the total GR-S produced in government plants. It is expected that this percentage may reach close to 40-45% in the next nine months.

Some 55 bids were received for the 28 rubber facilities now owned by the government. The bids were closed May 27 and the result of the negotiations will be known approximately Dec. 27. The negotiations are being conducted in as completely unbiased a manner as is possible.

It is generally surmised that the copolymer facilities were bid in by rubber companies, but apparently there is intense competition for the butadiene facilities. It has been rumored that there are as many as 12 bidders for the single styrene plant located in Torrance, Calif.

The principal factors in the copolymer field are the four major rubber companies, Firestone, Goodrich, U. S. Rubber and Goodyear; the Copolymer group, composed of eight medium sized rubber companies; an independent petroleum refiner, Phillips Petroleum Co.; a group of 29 small rubber companies working collectively unler the name of The American Synthetic Rubber Corp.; and General Tire & Rubber Co., the largest of the independents outside of the big four. Apparently there has been no bid for the large copolymer plant at Institute, W. Va., which has not been modernized in any respect from the days of its first construction.

The two butyl rubber plants, it is rumored, have been bid in by their present operators, namely Esso Standard Oil Co and Humble Oil and Refining Co.

The government program also owns some 450 pressurized tank cars for the transportation of butadiene and there was intense competion for this fairly large lot of pressurized vessels.

There is much speculation as to the fate of the disposal program should there be a change in political climate in November. A great many people feel that if there is a change for a Democratic Congress the chances of disposal of the rubber facilities will be greatly lessened. If this occurs it is rumored that a great many companies go out on their own and construct new facilities to take care of their needs.

The rubber disposal act of 1953 plainly says that there shall be, if possible, a broadening of the base of ownership of the rubber facilities. This is interpreted to mean that companies other than rubber and petroleum companies would be eagerly invited to participate in the bidding. The roster of bidders as revealed by the press releases from the Rubber Disposal Commission indicated that such was the case, although a preponderance of rubber and oil companies made up the entire roster. A great many chemical companies submitted bids, among them being Allied Chemical & Dye Co., Merck & Co., Climax Molybdenum Co., Foster Grant Co., Heyden Chemical Co., Monsanto Chemical Co., Koppers Co., Food Machinery and Chemical Co., and Grace Chemical Co. The indication of such interest is very heartening as it demonstrates that the future of rubber is well thought of by a broader range of people than those who presently produce it.

It must be recognized at the outset that the philosophy of the rubber industry and the philosophy of the oil industry are rather foreign to each other at the present time. The philosophy of the oil industry as a chemical producer has come a long way since 1942 when it was presented with the problem of making a fine chemical in tonnage quantities. When one views their achievement of producing a chemical of 99+ purity, i.e., butadiene, in vast quantities, it is apparent that they have displayed superb skill, of which probably they themselves were unaware. The chemical industry speaks of vast quantities in terms of pounds, and butadiene production is between a billion and a billion and a half pounds annually. This in terms of barrels means between four and six million barrels annually, which is not an impressive figure in today's roster of petroleum products. The rate of return on rubber chemicals is higher than on the straight refining of petroleum, but the payout terms are much longer.

However, the leveling of the philosophy of the petroleum industry, as has been previously pointed out, is in process. The petroleum industry is coming around to the viewpoint that they now are a chemical industry and that the "gold in them thar hills" is there for the picking. There is a petrochemical department in nearly every major oil company, and indeed in many of the minor ones. The voice of these departments is getting stronger every day in management affairs.

Rubber chemicals are attractive to these new divisions for they represent chemical volume and good return on the invested dollar. They represent also a footstep into larger participation into the chemical industry. Besides new technology problems, they also present new problems of marketing which have not been common to the petroleum industry. They are being introduced to a new type of competition which they have never experienced before. Again, it is felt strongly that this is an excellent, helpful approach. It adds versatility to a dynamic industry.

A great many authorities on petrochemicals see the pattern of the next two decades as follows: (1) The use of natural gas as a chemical raw material will decline by virtually being forced out of the market. It is a premium domestic fuel for which there is an insatiable demand. (2) The volume of liquefied petroleum gases will rise to such heights that it will keep their price down to a figure that will force their use as the prime petrochemical raw material. Synthetic rubber has its entire roots in LPG, and the upgrading of LPG through this route has excellent potential. During July of this year, the first private *Butadiene from Butane* plant was announced by the Texas Butadiene and Chemical Co., of Houston, Texas. Firm plans for a 40,000 ton unit are ready and erection will get under way shortly. Soup's on, boys, come and get it.

Private Synthetic Rubber Facilities in the U. S.

B. F. Goodrich Chemical Co., with plants at Louisville, Ky., Avon Lake, Ohio, and Akron, Ohio, manufactures acrylic polymers, as well as some styrene-butadiene polymers.

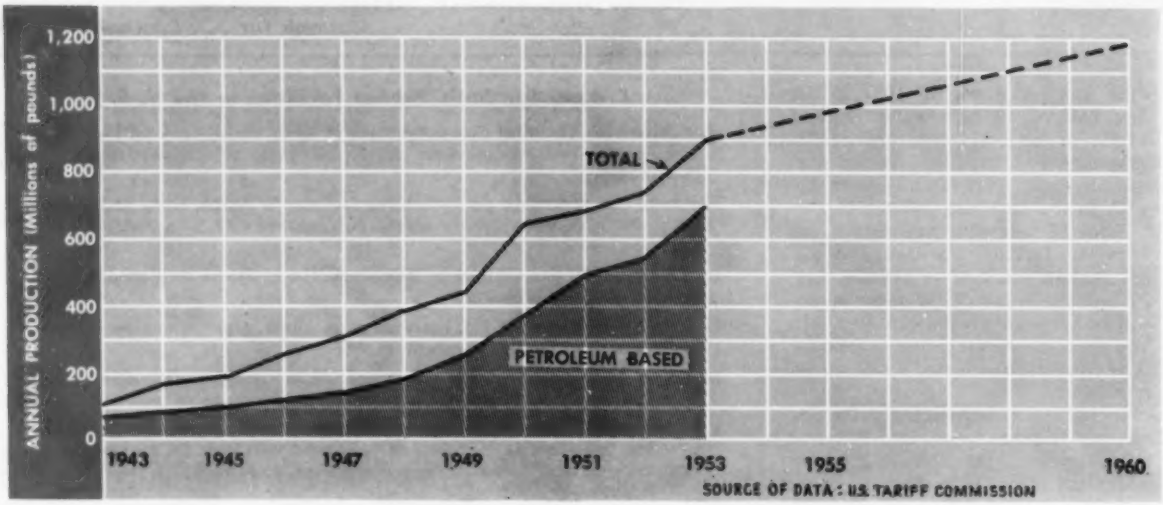
Firestone Tire & Rubber Co., which has facilities at Akron, Ohio, and at Pottstown, Pa., also manufactures acrylic polymers as well as a wide variety of synthetic latices.

U. S. Rubber Co. has facilities at Naugatuck, Conn., where they conduct a general line of polymerizations.

Goodyear Tire & Rubber Co. has a plant at Akron, Ohio, where they produce the "Chemigum" line of synthetic rubbers.

Dewey & Almy Chemical Co., Cambridge, Mass., has polymerization facilities in Acton, Mass., and also in Cambridge.

E. I. du Pont de Nemours & Co. owns and operates the neoprene plant at Louisville, Ky., built during the war and operated by du Pont for the government until 1949, at which time it was purchased by du Pont.



OUTPUT OF SYNDETS from petroleum last year represented over three fourths of the total production of organic surface-active agents

PETROCHEMICALS — TOMORROW

The Outlook for . . .

Synthetic Detergents

By FOSTER DEE SNELL
Foster D. Snell, Inc., New York

BECAUSE of their phenomenal growth in the last few years, synthetic detergents are of lively interest to the producers of the raw materials from which they are made.

And foremost among the raw materials—volume-wise—are petrochemicals. Although they are apparently headed for strong competition from other raw materials, petrochemicals accounted for about 77% of the "syndets" (short for synthetic detergents) produced in the U. S. in 1953—compared to about 41% in the first postwar year, 1946. At the same time, total output of syndets has more than tripled.

Two major types of syndets are in commercial production today:

1—Anion-active agents, and

2—Nonionic agents.

The bulk of the petroleum-derived syndets are of the anion-active type. They are commonly known as alkyl aryl sulfonates, and are usually the sulfonated product of an alkylate made from a cyclic hydrocarbon and a chain hydrocarbon. Today, benzene and propylene tetramer are the petrochemical raw materials. In the past, toluene was used to some extent but was abandoned because of hygroscopic tendencies; kerosine at one time provided the chain hydrocarbon, but is now of little significance in the U. S.

The nonionic agents are of lesser importance in terms of their share of the total output, but depend on petroleum to a greater extent. Practically all of the better known nonionic syndets include a polyoxyethylene chain (built up from ethylene oxide) and many an alkyl substituted phenol.

Anion-active agents today constitute the major type of syndets, as previously pointed out. They are typified by dodecyl benzene sulfonates, which petrochemical-wise consume benzene and a hydrocarbon chain.

Initially, the alkylate for their production was made from a kerosine fraction boiling at 185-275° C., which was chlorinated to form keryl chloride and combined with benzene by the Friedel-Kraft reaction. The chain length of the alkyl group varied, but averaged 10-16 carbon atoms, and was joined to the ring randomly.

Present source of the alkyl group is propylene tetramer, made by polymerizing purified propylene in the presence of a suitable catalyst, often a fluoride, sometimes phosphoric acid. The dimer which first forms:

$$2CH_2{:}CH{\cdot}CH_3 \rightarrow CH_2{:}C(CH_3)C_3H_7$$

reacts with itself or with more monomer. Fractional distillation of the polymerizate gives the desired dodecene.

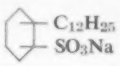
Ample supplies of dodecene are available as a by-product fraction from other processes of the petroleum industry.

Alkylation of the benzene and propylene tetramer is then carried out at 10-15° C. in the presence of 96% sulfuric acid as catalyst. The washed alkylate is fractionally distilled to separate dodecyl benzene from unreacted material and products formed by side reactions. This product is then largely sold to major syndet producers —established soap companies—who carry out the remaining steps. However at least two petroleum companies sulfonate and sell sodium dodecyl benzene sulfonate slurry to smaller producers. They in turn build the slurry, and dry and market the built product.

Sulfonation of the alkylate is usually with 20% oleum at a ratio of about 1.25 parts of oleum to 1 part of alkylate. By cooling, slow addition of oleum, and agitation, the reaction temperature is kept to 25-30° C. The conditions of sulfonation vary from one plant to another, but must be controlled to prevent side reactions, oxidation, oversulfonation, discoloration, etc. One of the more recent methods involves a continuous process with use of liquid sulfur trioxide, absorbed in liquid alkylate from the vapor phase. This process avoids use of excess sulfonating agent and so reduces the

amount of caustic soda needed for neutralization. The product then may be 90% active or better, with only 10% or less of sodium sulfate present. Even in the batch process, the effort is to develop methods to produce a higher percentage of active agent—in contrast to the old method where 60% of active agent was standard, with a corresponding amount of sodium sulfate remaining in the product.

Neutralization of excess acid and of the acid derivative formed by reaction, is next necessary. Caustic solution is used at a concentration of 20-30%. A light-colored slurry results, sometimes bleached with hypochlorite to improve the color. The active ingredient is assigned the representative formula:



To produce heavy-duty products suitable for general laundry and household cleaning, the slurry, containing about 45% of solids, is admixed with a large percentage of sodium tripolyphosphate, a smaller amount of liquid sodium silicate, a fraction of a per cent of sodium carboxymethylcellulose, a per cent or two of foam stabilizer, and a trace of substantive fluorescent colorless dye to give improved whiteness of laundered white goods. The pH of this slurry, at 55-60% of solids, is then adjusted to around 10.2-10.4 with soda ash for spray drying to a density of around 0.3 for household sale. Some lesser amounts are drum dried to a denser product.

Nonionic agents are produced in less volume than are the anion-active agents; the share of petroleum in their production, however, is greater.

While nonionics as a class include complex fatty-acid amides, polyhydric alcohol esters and ethers, and other forms, the majority of the commercial products depend on a polyoxyethylene chain as the polar portion. The nonpolar portion of the molecule may be a long-chain alcohol such as dodecyl alcohol, or an alkyl phenol, either of which forms an ether with the polyoxyethylene chain. The latter is built up to a desired chain length from ethylene oxide derived from petroleum. Changing the length of this chain permits variations in properties. Both the phenol and the alkyl side chain—usually about C_9—can be from petroleum. Thus nonionics are often entirely petroleum derived, a C_{12} mercaptan and ethylene oxide for example. The key to larger sales to set lower prices is cheaper ethylene oxide.

Currently large advertising effort is pushing low-sudsing detergents for

Producers of Syndets and Intermediates from Petrochemicals

Company and Plant Location	Raw Materials and Intermediates*	Syndet Products**
Allied Chem. & Dye Corp. (National Aniline Div., Buffalo, N.Y.	benzene, kerosene, chlorine, keryl benzene	Nacconol
Atlantic Refining Co. Pt. Arthur, Texas	benzene, propylene, propylene tetramer, alkylate	Atlantic Alkylates #2 Ultrawet
Atlas Powder Co. Atlas Point, Del.	tall oil, ethylene oxide	Renex (nonionic)
Carbide & Carbon Chemical Co. S. Charleston, W. Va. Texas City, Texas	natural gas, phenol, ethylene oxide, propylene oxide, octylphenol (mono-, di-, tri-ethanolamine)	Tergitols
Continental Oil Co. Baltimore, Md. and elsewhere	benzene, propylene, unsaturated hydrocarbons, hydrogen sulfide, propylene tetramer, C_{12} mercaptan, alkylate	Neolene #400
Dow Chemical Co. Midland, Mich. Freeport, Texas. Pittsburg, Calif.	natural gas, benzene, phenol, mono-, di-, tri-ethanolamine	none
Esso Standard Oil Co. Baton Rouge, La.	benzene, propylene, higher alcohols, propylene trimer, propylene tetramer, alkylate	none
General Aniline & Film Corp., Linden, N.J.	phenol, ethylene oxide, alkylated phenols	Igepals CO & CA
Jefferson Chemical Co. Pt. Neches, Texas.	ethylene oxide, phenol, alkylated phenols	custom nonionics
Monsanto Chemical Co. St. Louis, Mo.	benzene, propylene tetramer, tall oil, ethylene oxide, alkylate	Santomerse Sterox
Oronite Chemical Co. Oak Point, La.	ethylene oxide, phenol, alkylated phenols	Oronite Dispersant (nonionic)
Ninol Laboratories Chicago, Ill.	alkyl phenol, alkylated benzene	nonionics
Pan-Am Southern Corp. El Dorado, Ark.	propylene, butylene, propylene tetramer, polybutylene	none
Rohm & Haas Co. Philadelphia, Pa.	propylene, benzene, phenol, ethylene oxide, alkylated phenols	Triton X100 and others
Sharples Chemical Co. Wyandotte, Mich.	ethylene oxide, C_{12} mercaptan	Nonic No. 218
Shell Oil Co. Houston, Texas. Wilmington, Calif.	benzene, propylene, propylene tetramer	none
Standard Oil Co. of Calif. Richmond, Calif.	benzene, propylene, proylene tetramer	Oronite Alkane
Standard Oil Co. (Ind.) Whiting, Ind.	benzene, propylene, propylene tetramer	Indoil detergent alkylate
Wyandotte Chemicals Corp. Wyandotte, Mich.	benzene, kerosene, ethylene oxide, proylene oxide, alkylate	Kreelon Pluronics

* Where companies are referred to as using propylene for production of propylene tetramer, the operation is often carried out for them by one of the large oil companies.

** Where a company is shown as making no product, the petrochemical intermediate is sold as such. Other companies often sell the intermediate as well as the product shown.

the horizontal type of automatic washer. Other than that, sales are predominately industrial.

The market for syndets has been partly in the direction of replacing soap for household use, and partly of creating new uses and applications in industry. The demand could not be met until sometime after the war because of three bottlenecks—alkylate, sulfuric acid, and sodium tripolyphosphate. All of the required materials are now in ample supply so that a strictly competitive situation exists.

The major market is in the household. There in 1953 the production and sale of close to 2 billion pounds of built syndets can be "guesstimated" to have consumed about 600 million pounds of active agent. Probably close to 200 million pounds additional were consumed industrially. Those quantities by no means saturate the market.

A fair estimate of the potential market by 1960 is 1.2 billion pounds of active agent with about 900 million pounds of it going into household products, largely heavy-duty. We do not mean to suggest, however, that the composition of the product of 1960 will be the same as that in 1954, which in turn differs substantially from that of 1948.

The export market for syndets is negligible, although they are produced in nearly every civilized country on a lesser percentage basis when compared with soap than in the U.S. The U.S. export market for alkylate has been a rapidly expanding one because of the large investment required for its production. Even soft-currency countries have been able to acquire dollars for the 10-20% by both weight and cost of alkylate required for sulfonation and building into the heavy-duty syndet. The ratio is much larger for light-duty syndets.

That field has a none-too-bright future. There is manufacture of alkylate by Monsanto in England, Kuhlmann in France, Montecatini in Italy, and Shell in Curacao, to mention only a few.

Competition is becoming intense among the various types of raw materials which can be used to make syndets. In the field of anion-active agents, the immediate postwar competitor was fatty alcohols from coconut oil. At one time they had over 50% of the market, probably have less than half that today. But the fatty alcohols are once again becoming a strong raw material contender—although being produced from a different source than coconut oil.

Because of the adaptability of the petroleum industry and the desire of many companies to produce products more valuable than fuels, there was rapid increase in alkylate capacity in the latter part of the last decade. The syndets rapidly displaced soap in large parts of its market—in 1953 syndet sales exceeded soap sales. Nearly every pound of market lost to soap left a pound of surplus inedible tallow. European demand took the surplus for a time at fancy prices. Then the price of tallow declined so that in 1952-3 it ranged from just over 3¢ to under 6¢ a pound. Recently it has passed 7¢ at times. At those prices, set by the large surplus, it competes on a cents per pound basis with petroleum derivatives.

The net result is that fatty alcohols are being produced from tallow. New capacity is coming in and the raw material which petroleum alkylate displaced from the soap market is coming back to compete with alkylate in the syndet market. The price of tallow will probably not be substantially over 7¢ for at least a few years because arbitrage with yellow corn fixes it at that level as a feed for animals and poultry.

The magnitude of the competition is indicated by consumption of tallow in syndets: 1952, 88 million pounds; 1953, 250 million pounds. Roughly each pound of tallow displaces a pound of alkylate.

The future outlook is mixed. Markets for the end products will undoubtedly continue to grow—but there are some questions as to where the raw materials will come from.

The continued expansion of the household market probably has as a ceiling the displacement of 75% of soap as compared with the present 50%. Even that is optimistic as some 15-18% of soap goes into industrial markets, of which a considerable part goes to laundries. After that, expansion will depend on population growth, with petroleum battling it out with fat sources to provide the nonpolar fractions of the molecules.

Industrial markets for syndets, other than steam laundries, have been cultivated for a longer time than the household market. Nevertheless, further increase in that field is to be expected.

Published research on surfactants from tallow has not as yet led to commercial products—other than the tallow alcohol sulfate—but knowing the amount of work being done it is inevitable that there will be other competitive products. If produced from the fatty acid they could be lower in cost. A low price surplus always develops a market.

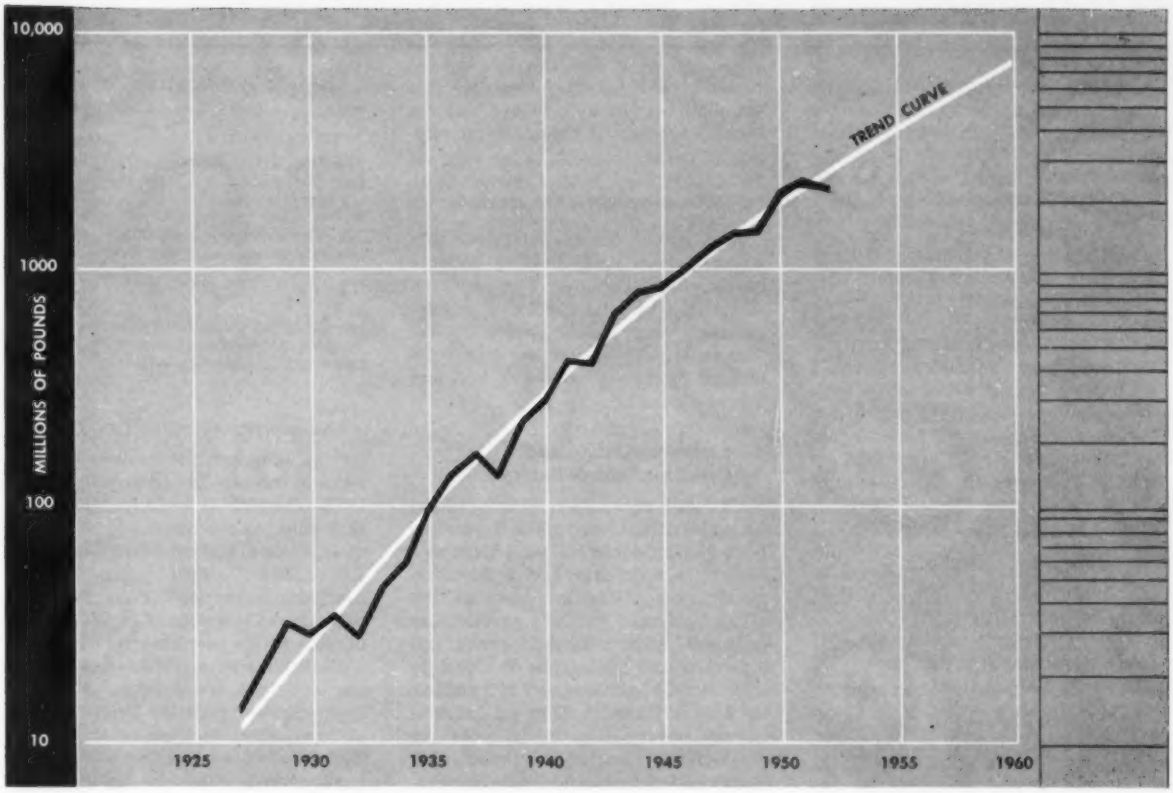
Research in the petroleum industry may well come up with new surfactants. While the product of sulfonacially satisfactory product when made with propylene tetramer, it is not as effective pound-for-pound in competition with fatty alcohol sulfates.

One thing can be relied on. Syndets built in 1960 will contain very substantial amounts of other surfactants than the three major ones in use today —dodecylbenzene sulfonate, coconut alcohol sulfate, and tallow sulfate.

Because of the differences in marketing methods it is improbable that petroleum companies will go beyond some raw material stage on any large scale. Thus they can be expected to supply the syndet industry with benzene, phenol, substituted phenols such as nonyl phenol, ethylene oxide, dodecylbenzene, sodium dodecyl benzene sulfonate, and whatever else they can produce for such new structures as are developed. So far as domestic alkylate sales are concerned the peak may well have been passed.

Meet the Author

Foster Dee Snell is president of Foster D. Snell, Inc., New York, consulting chemists and engineers. He received his B.S. from Colgate University, and his M.A. and Ph.D. from Columbia. He taught chemistry at Columbia and at the College of the City of New York and was in charge of Technical Chemistry at Pratt Institute from 1923-28. During World War II he was a member of the Referee Board of the Office of Production Research and Development—from 1941 to 1945. Dr. Snell has been president of the American Institute of Chemists (and received the honor award of the New York Chapter of that group in 1952), and vice president of the Society of Chemical Industries (England).



U.S. PRODUCTION OF ALL SYNTHETIC RESINS—over 3 billion lbs. last year and a market for an estimated 14% of all petrochemicals

PETROCHEMICALS — TOMORROW

The Outlook for... Plastics

By PETER W. SHERWOOD
Chemical Engineer
White Plains, N. Y.

IN 1953, the plastics industry consumed an estimated 14% of all petrochemicals produced in the United States. It is thus the fourth largest outlet for petroleum-derived chemicals, following after the rubber industry (20%), automotive and aviation (17%), and synthetic fibers (15%).

The growth potential of the plastics industry is startling. During the last 30 years, it has increased each year save four. Total 1953 production is estimated in excess of 3 billion lb., a 30% increase over the previous year's output, and a doubling of production since 1949.

What we term, somewhat loosely, the "plastics industry" is really a conglomerate of manufacturing operations in which wholly synthetic or chemically modified natural polymers serve as basic raw material. The same general definition could also be applied to the rubber and synthetic fibers industries, and there is a certain overlapping between these three segments of the economy in regard to raw materials as well as to end uses. However, the broad consumption pattern differs clearly.

By no means does the entire plastics industry look to petrochemicals as a major source of supply. Indeed some very important branches—casein plastics, coumarone-indene resins, etc.—derive their major raw materials from altogether different sources. Others, such as cellulose nitrate, look to petrochemicals for only some of the ultimate raw materials. But the great majority of plastics and resins involve the use of petroleum-derived chemicals, often in more than one important function.

It is clear, of course, that in many of these fields, the same raw materials may be derived from various sources. The coke and coal tar industries still supply about three-fourths of the nation's benzene, a prime raw material for the production of phenol and styrene. Coal gasification continues to be an important source of ammonia from which urea and melamine are derived. Acetylene, a major raw material in the production of vinyl chloride and of acrylonitrile, is still principally generated from calcium carbide.

However, in all of these fields petrochemical operations have in recent years shown a lusty growth. By far the greater portion of the last five years' expansion has been based on petroleum stocks as ultimate raw materials, and future expansion in plastics production will look to petrochemical sources in ever-increasing measure.

A classification of the plastics in-

dustry's main branches with a petrochemical background is possible on the basis of the principal raw materials involved:

Thermoplastics

A—Cellulosic Resins
- 1—Cellulose Acetate and Cellulose Acetate Butyrate
- 2—Ethyl Cellulose

B—Synthetics
- 3—Polystyrene
- 4—Acrylics
- 5—Vinyl Resins
- 6—Vinylidene Chloride
- 7—Polyethylene
- 8—Nylon
- 9—Fluorocarbons

Thermosetting Resins

- 1—Phenol-Formaldehyde
- 2—Phenol-Furfural and Resorcinol-Formaldehyde
- 3—Aminoplastics (Melamine and Urea Derivatives)
- 4—Polyesters

In the manufacture of these products, the principal call on the petrochemical industries is, of course, for the supply of raw materials for the polymeric base substance (binder). In addition, the plastics industry consumes a host of other chemicals—catalysts and dispersion agents for the polymerization process, lubricants, inhibitors, organic solvents, plasticizers, etc. In the field of plasticizers, the following petrochemicals assume outstanding importance:

- 1—Phthalic anhydride
- 2—Maleic anhydride
- 3—Primary alcohols (methanol to butanol, 2-ethyl hexanol, diisooctyl alcohol)

Raw materials for the production of the above group of plastics and plasticizers constitute the principal link between the petroleum and plastics industries. The extent to which any one petrochemical depends for its market on plastic production varies widely, ranging from 22% for ethylene to nearly 100% for methacrylates. Acetic anhydride, of which 95% goes into the production of cellulose acetate, shares its ultimate use between the plastics and textile industries. Almost all styrene serves as raw material for polymerization or copolymerization reactions. But only 65% of its total production enters the plastics industry, while most of the rest is sold to synthetic rubber plants.

Evidently, the growth potential of petrochemical sales to the plastics industry is directly related to the prospects of that industry's several main branches. It is within this relation that we shall best be able to evaluate the outlook for petrochemicals in the plastics industry.

Thermoplastic Materials

This group covers polymeric substances which upon heating undergo only a physical change. Thermoplastic materials will soften at elevated temperatures and harden when cooled. The same material may be repeatedly molded by the application of heat and pressure.

1—Cellulose Acetate and Cellulose Acetate Butyrate

Cellulose acetate is one of the oldest members of the plastics family, having been first produced in 1927. Since that time it has become by far the most important member of the group of cellulosic plastics. In 1951, production (together with cellulose acetate butyrate) was 92.9 million lb., and in 1953 output had risen to 115.1 million lb. This is about 89% of all cellulose plastics produced in the U. S. (These production figures do not include cellulose acetate consumption in camera, movie and X-ray film, on which no data are available.)

Closely related to cellulose acetate is cellulose acetate butyrate (CAB), in the manufacture of which butyric anhydride is substituted for part of the acetic anhydride. This opens the way to a wide range of plastic properties by varying the ratio of butyrate to acetate radicals introduced into the cellulose molecule. In many applications, this newer (1932) material shows considerably better properties than cellulose acetate (e.g. better moisture resistance, higher strength and impact resistance).

This line of plastics is characterized by outstanding impact strength and durability. Other properties which assist in the marketability of cellulose acetates are their good electrical resistance, a wide range of attractive translucent, transparent, or opaque colors, and excellent moldability.

Against these advantages weigh the serious deficiencies of cellulose acetate and CAB—low tensile strength, poor resistance to acids and alkalis, and low surface hardness. Moisture resistance is only fair. Tolerance for a number of common solvents (e.g. acetone) is unsatisfactory, but contact with hydrocarbons causes no damage to CAB, and this material has recently made its debut in long-distance transmission pipe for petroleum products. For this application, CAB is well suited by virtue of high resistance to heat distortion and weathering.

The production pattern of cellulose plastics in 1953 was as follows:[1]

End Use of Cellulosics	Million lbs.	%
Cellulose acetate and CAB sheets under 0.003 gage*	17.5	13.6
Sheets, 0.003 gage and over*	14.1	10.9
All other sheets, rods, tubes*	5.9	4.6
Molding and extrusion materials*	77.7	60.2
TOTAL*	115.2	89.3
Nitrocellulose: sheets, rods, tubes	7.6	5.9
Other cellulose plastics, primarily ethyl cellulose	6.3	4.8

* Includes plasticizers, filler, and extenders.

This branch of the industry has suffered in recent years from competition by other plastics. Molding and extrusion outlets have receded from the 1946 all-time high of 83 million lb. to 77.7 million lb. in 1953. Nevertheless, molded cellulose acetate end products have staged a comeback since their low of 48.5 million lb. in 1948.

Illustrative of molded cellulose acetate end uses are a large variety of toys, combs, vacuum cleaner parts, electrical switchplates, zippers, etc. Extruded cellulose acetate finds important application in electrical cable insulation. The material is also the polymeric base for a number of surface coatings.

Cellulose acetate butyrate moldings find their most important outlet in the automotive industries where they serve in steering wheels, arm rests, etc. Other important applications include telephone sets, portable radio cases, tool handles, and markers for traffic lanes. Butyrate pipe for gas, petroleum and water transportation purposes is finding increasing application.

The slump which affected cellulose acetate as a whole in recent years did not extend to the production of acetate film, which has grown from 15.0 million lb. in 1947[3] to last year's 31.5 million lb. (again, this does not include film for photographic use). The wholly transparent appearance of acetate film has led to wide-spread acceptance in the packaging of soft goods, and for a large number of other display applications.

As a class, the outlook for cellulose acetate plastics is one of continued growth in already established markets. With the possible exception of butyrate pipe, there is no development now on the horizon which promises to give strong impetus to the natural gradual expansion.

2—Ethyl Cellulose

This plastic finds a variety of specialty applications. It is characterized by low water absorption, good chemical stability and high impact strength

over an unusually wide range. It also has very good electrical properties (among them a very high breakdown voltage) and is of low density. Ethyl cellulose finds use in transparent shields for industrial equipment, in coatings for ignition cables, various radio parts, advertising novelties, etc.

U. S. Tariff Commission data indicate a 1953 production of about 6 million lb. In the production of ethyl cellulose, petrochemical ethyl chloride is consumed at the approximate rate of 1,900 lb. per ton.

3—Polystyrene

Utilization of styrene in thermoplastics, alone or as copolymerizing agent, is today the largest single outlet for this commodity (492.3 million lb. in 1953). In second place stands styrene consumption in the production of synthetic rubber (app. 290 million lb.). Smaller but still significant amounts of this monomer enter the plastics industry in the manufacture of (thermosetting) polyesters. These uses will be considered separately.

Polystyrene plastic is characterized by excellent electrical properties (low power factor and high dielectric strength) and by very high light transmission and clarity. It offers good resistance to water, acids and alkalis, alcohol, and most foods and drinks. Polystyrene-molded articles are completely free of odor, taste and toxicity. Other valuable properties are good rigidity and dimensional stability.

On the side of polystrene's deficiencies are a tendency to weathering. Hydrocarbons and a number of common household solvents (cleaning fluid, nail polish remover, etc.) attack the material. There is a tendency to soften just below the temperature of boiling water, although special grades are now on the market in which this shortcoming is less pronounced. While polystyrenes have fairly good surface hardness they must not be cleaned with abrasives.

Probably the most serious single deficiency of polystyrenes is low impact strength. This difficulty has been overcome to a large extent in the recent development of so-called "high-impact" polystyrene which is, in effect, a styrene-acrylonitrile resin, modified with a butadiene-acrylonitrile rubber. This innovation has expanded the horizon for polystyrene resins, but the improvement of impact strength has been gained at the expense of other valuable properties, notably a reduction in tensile strength and an increase in aging susceptibility. At the same time, molding behavior is affected.[4, 5]

The major portion of styrene resins are used in molding applications. This end use required a 1953 production of 322.7 million lb. Next in order of importance is the use of styrene polymers in protective coatings—largely in rubber-base paints. Production of styrene resins for this application amounted to 84.4 million lb. An almost equal amount went into miscellaneous uses—foams, ion exchange resins, etc.

The end products for molded polystyrene resins are estimated by Modern Plastics[2] to follow this pattern:

Refrigeration and air conditioning	19%
Housewares (incl. combs and toilet articles)	20%
Toys	17%
Wall tile	14%
Packaging	9%
Radio and television	7%
Miscellaneous	14%

The growth outlook is greatest for high-impact styrene copolymers. An estimate places 1953 production at 85 million lbs. and forecasts a volume of 150 million lbs. for 1954. A bright future is seen for this type of resin in the rapidly expanding market for plastic pipe. While acrylonitrile-modified polystyrene covered only 7-8% of the demand for plastic pipe in 1953, the material is inexpensive and rugged enough to offer serious competition to cellulose acetate butyrate for second place in this market.[6]

An important new development now in the wind may be the large-scale application of polystyrene in the production of phonograph records. Already firmly established and receiving wide popular acceptance is polystyrene wall tile, now in its seventh year of commercial production. Beads impregnated for in-situ production of polystyrene foams are now available for thermal insulating purposes and other promising applications.

In all, the past growth of polystyrene plastics and resins has been little short of astounding (an increase of 23% during 1952 and a doubling in capacity since 1949). The future promises continuance of this strong upward trend for a number of years to come. Extrapolation of the Gompertz trend curve* for this commodity forecasts an 800 million lb. per year production by 1960 (see Fig. 1), an estimate also borne out by Kuhn and Hutcheson's study of ethylene markets.[7] The President's Materials Policy Commission[8] anticipates styrene utilization for polystyrene thermoplastics in the amount of 700 million lb. by 1960, 1.5 billion lb. by 1975.

During 1953, vinyl toluene, a petrochemical monomer closely related to styrene, was introduced by Dow Chemical Co. Its indicated lower cost makes it a product of potential interest in fields which parallel the applications of polystyrene. There are still some drawbacks (such as greater brittleness) to vinyl toluene-derived molded products.

4—Acrylics

The polymers of acrylic and methacrylic esters were first offered commercially in 1936. After early rapid acceptance, the demand for this line of plastics has tended to level off, largely due to competition from less costly polystyrene and polyesters. Production of polymethacrylates in 1952 is estimated to have been between 35 and 40 million lb., an increase of 10 million lb. over a slump experienced during 1949, but barely exceeding output during the war years. There is indication of anticipated expansion in methacrylates as well as acrylates.

During 1953, Rohm and Haas Co. initiated operation of its $8,000,000 Deer Park, Texas, *acrylate* plant which employs a novel method of synthesis based on acetylene and carbon monoxide. All prior production of this group of monomers had involved intermediate synthesis of ethylene cyanhydrin from ethylene oxide. Almost the entire output of *methacrylates* is based on the hydrolysis of acetone cyanhydrin.

The best outlook for acrylate esters (as distinguished from methacrylates) is seen in its copolymers with a wide range of other monomers. For example, copolymerization with vinyl chloride can be readily effected to yield an internally plasticized resin, i.e., a material which can be properly molded without addition of a plasticizer. A prime advantage is the absolute permanence of this type of plasticization.[9] Properly compounded copolymers of various vinyls with acrylate also show improved heat and light stability compared to the corresponding vinyl homopolymer.

A most important present use of acrylate resins is in film-forming applications, notably in the form of aqueous latex-type coatings. Resistance to lime has led to the adoption of acrylate paints in some branches of the construction industry. Significant amounts of acrylates are also used by the leather industry, where they serve in finishing operations to impart low-temperature flexibility and other valuable properties; by the textile industries, which employ acrylate dispersions as finishing agents for improving the mechanical properties (tensile and tear strength, wear resistance, etc.) of cotton and rayon; and by the paper industry, where acrylate dispersions are

* The Gompertz curve permits fairly accurate description of numerous economic trends according to the equation:

$$\log Y_c = \log K + \log a\ (b)^x$$

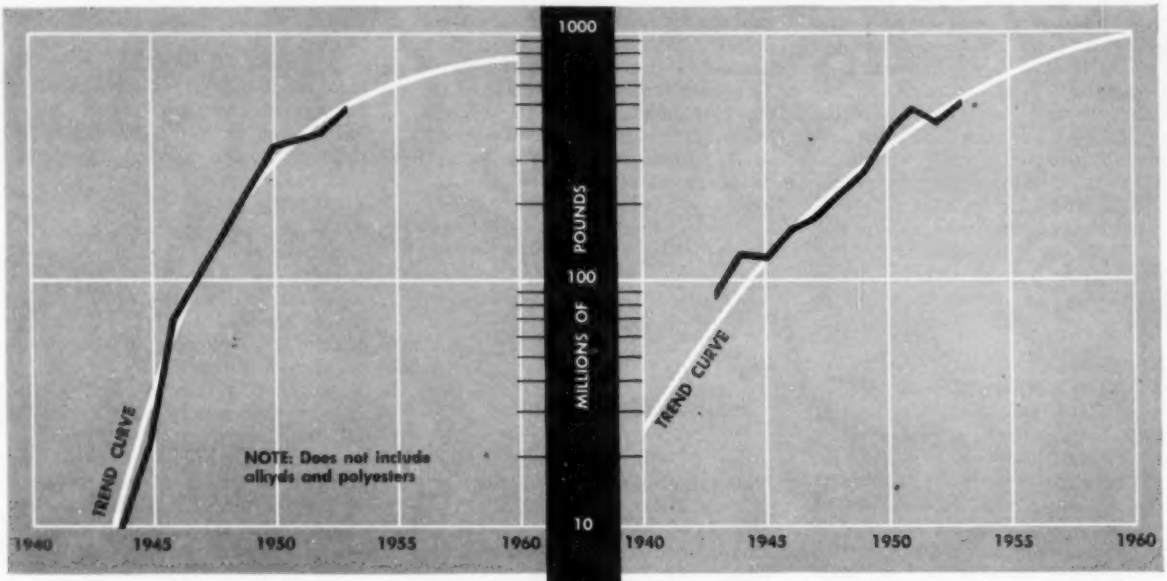


FIG. 1—STYRENE plastics and resins, U.S. production

FIG. 2—VINYL resins and copolymers, U.S. production

employed in various coating and adhesive applications.

Polyacrylates have shown promise as soil stabilizers, obviously an application of vast potential. However, early bright prospects in this field have of late been dimmed by difficulties and expense in application and by the promise shown by competitive and less costly materials.

Thus, the major applications of polyacrylates are on the fringes of the plastics industry proper. Polymethacrylates, on the other hand, find their chief end use in molded products of various types. Here, the material has been given wide acceptance for purposes which require its combination of excellent properties: attractive appearance, outstanding optical clarity, resistance to weathering, good dimensional stability, and resistance to attack by aqueous solutions of salts, acids and weak alkalis, as well as by most oils. Plastics in this category have high impact strength and good electrical properties.

While the excellent optical properties and toughness of polymethacrylates make them a natural choice for many glazing purposes this application is somewhat limited by low surface hardness and by a high coefficient of expansion which necessitates special provision in mounting.

In the marketing of this product, increasing emphasis is being placed on construction purposes. Corrugated polymethacrylate sheet is being employed for commercial structures; skylights and luminous ceilings made of "Plexiglas" (Rohm and Haas Co.'s poly-methyl methacrylate) are finding acceptance. Use has been made of this material in automobile windows and tops, and in airplane windows and cockpit enclosures.

Outdoor signs and store fronts are the largest civilian outlet for acrylic sheet, estimated by Modern Industries[2] to make up one-half of the total market.

5—Vinyl Resins

This useful class of plastics, commercially introduced in 1937, is derived from monomers of the basic pattern $CH_2=CH-X$, where X is a functional (i.e., non-hydrocarbon) group. U. S. production of vinyl resins in 1953 amounted to 511.4 million lb., domestic sales were 480.3 million lb. Polyvinyl chloride, by far the most important member of the group, accounted for 380.4 million lb., or 79.2% of the total domestic sales (these figures include the resin content of copolymers containing more than 50% PVC).

Second in importance are polyvinyl acetate and polyvinyl alcohol, followed further by polyvinyl acetal, polyvinyl butyral, and other related plastics.

The principal members of this group are, of course, very definitely within the scope of petrochemicals. The monomer vinyl chloride is produced commercially by dehydrohalogenation of 1,2-dichloroethane or, alternatively, by the addition of hydrogen chloride to acetylene. Vinyl acetate is a derivative of acetic acid and acetylene, as is also polyvinyl alcohol. The butyral polymer is produced by reaction of polyvinyl alcohol with butyraldehyde.

For molding and extrusion applications, polyvinyl chloride (except in a few copolymeric modifications) must be heavily plasticized. Most commonly employed for this function are dioctyl phthalate and tricresyl phosphate, which are introduced to a final content ranging from 10-50%.[10, 11] Both of these plasticizers, as well as related compounds used in this function, have their roots in petrochemicals.

Here is the end-use pattern obtained during 1953 in the domestic consumption of the vinyl resins:[1]

	Sales Pounds	%
PVC and Copolymer Resins:*		
Film	63.7	13.3
Sheeting	62.4	13.0
Molding and Extrusion	129.2	26.9
Textile and Paper Treating and Coating	52.4	10.9
Flooring	22.2	4.6
Protective Coatings	22.8	4.8
All other uses	27.8	5.7
All Other Vinyl Resins:		
Adhesives (resin content)	22.4	4.7
All other uses	77.5	16.1
TOTAL	480.4	100.0

* 50% or more PVC—resin content only.

Polyvinyl chloride is available in a large number of forms. No one set of

properties may be said to characterize this group of plastics—even as a generalization. Their versatility stems from their compatibility with a wide range of fillers and plasticizers in large amounts.

Of outstanding promise among uses now extant is application in vinyl-type floor coverings. Sales in this field have approximately doubled during the past year alone.[2] Most common formulation in this application uses about 15% polyvinyl chloride as binder for asbestos and other fillers. Tiles as well as sheets are available forms of vinyl floor covering.

Extruded and molded products are the largest single outlet for vinyl resins. Wire coatings are reported[2] to have consumed between 50 and 60 million lb. of vinyl during 1953. Other important uses in this category include garden hose, phonograph records, film type storm windows, etc.

Much promise is shown by current public acceptance of vinyl-coated fabrics for new uses. Vinyl raincoats are, of course, already well established, but headway is now being made by vinyl-coated glass fabrics for window drapes, and various coated fabrics for men's jackets, waterproof mattress coverings, etc. Good oil resistance, flexiblity and retention of elasticity, as well as low cost, have led to adoption of polyvinyl chloride for wrapping underground pipe in protection against corrosion.

Copolymers of vinyl chloride and vinyl acetate find important applications due to their outstanding chemical resistance, low moisture absorption, good electrical properties, rigidity, moldability and machinability to close tolerances, and dimensional stability. They serve in such functions as pump gears, printing equipment, plating barrels, etc.

Homopolymeric vinyl acetate serves primarily in surface coatings and in adhesive applications where it shows affinity for a wide range of materials, coupled with good chemical resistance.

Polyvinyl butyral, the most important member of the acetal group of vinyl resins, finds wide application as interlayer in the production of laminar safety glass.

Fig. 2 traces the expansion of vinyl resin production in the U. S. A forecast by extrapolation of the Gompertz trend curve indicates an output of 650 million lb. in 1955 and nearly one billion lb. in 1960. There is today much activity in construction of polymerization facilities, which have already a combined capacity in excess of 600 million lb.

An even brighter picture for the future is seen by the Paley Commission report,[8] which forecasts vinyl resin production of 1.2 billion lb. in 1960 and 2 billion lb. by 1975.

6—Vinylidene Chloride Resins

Vinylidene chloride ($CH_2=CCl_2$), the monomer for this type of resin, is produced by the dehydrohalogenation of 1,2,2′-trichloroethane. It may be homopolymerized or entered into copolymerization, notably with acrylonitrile and acrylates.

Polyvinylidene plastics are characterized by excellent chemical resistance to most inorganic chemicals and to a wide range of organic materials, as well as by high tensile strength and wear resistance. The material is impervious to water, non-flammable, and dimensionally stable even when boiled in water. It is not recommended for applications where high-impact strength, shock resistance, and low-temperature flexibility are required.

Outstanding uses for this plastic include flexible tubing, rigid pipe, and lined steel pipe for corrosive chemicals, as well as fabrics for upholstery, bottle closures, collapsible tubes, etc.

No official production figures are available for polyvinylidene chloride, but an estimate places 1951 output at slightly more than 50 million lb. and anticipates considerable expansion. It should be noted that this estimate includes textile applications, which account for a considerable share of the market for polyvinylidene chloride.

Vinylidene chloride monomer is manufactured by Dow Chemical Co. which also markets the polymerized product under the trade name "Saran."

7—Polyethylene

Few chemical products have shown the tremendous growth history and potential of polyethylene. The product was first introduced in 1943. By 1952, output had passed the 100 million lb.-per-year mark, and last year's production is estimated at 140 million lb.

This is the only major plastic which continues to be in short supply. This situation should, however, soon be remedied. Its two present producers (du Pont and Bakelite) are in the course of large-scale expansion. Other companies are getting into this field and, at present outlook, 10 firms should be actively making polyethylene by mid-1955. Total plant capacity should be between 500 and 600 million lb. per year by then.

Polyethylene is, of course, a prime petrochemical. Its monomer is ethylene of very high purity. Polymerization takes place at pressures ranging from 15,000 to 30,000 psi. In this connection, interest attaches to Phillips Petroleum Co.'s recent announcement of a 500-psi. ethylene polymerization process which will be tested on a semi-commercial scale at this company's plant just outside Houston.

Official figures on polyethylene production and distribution are not available, but the output figures indicated above are believed to be quite accurate. Polyethylene consumption pattern has shifted markedly from early emphasis on electrical insulation to today's predominance of film for packaging purposes, a trend which is likely to continue. During 1953, U. S. outlets for polyethylene are estimated to have taken the following pattern:[12]

Film	30%
Wire and Cable	25%
Pipe	15%
Injection and molding	13%
Paper and coating	11%
Jars and bottles	6%

A striking feature of this plastic is the versatility with which it can be adapted to a wide range of uses by control of molecular weight, extent of cross-linking (a new development) and the influence of chemical after-treatment of the polymer (chlorination, chlorosulfonation).

A main attraction of polyethylene is its low cost. Currently, this low density product sells for 41¢ per lb. and the outlook is for a 10-20¢ per lb. reduction in the not too distant future. It shows good flexibility at temperatures as low as —70° F., and may be brought in contact with boiling water (but not for an extensive period). Above 230° F., polyethylene will fuse but higher temperatures may be handled with new cross-linked modifications.

Advantages which make polyethylene film an ideal packaging material are high tensile strength and non-permeability to water vapor. It does, however, permit passage of oxygen and carbon dioxide. This is often an advantage, but in applications where it proves to be a handicap, the difficulty is being overcome by lamination with cellophane.

The field of packaging applications, which consumes the lion's share of polyethylene, has been barely scratched. This use is gaining above all in food packaging for self-service stores, for shipment of vegetables and fruit.

There is expanding use in packaging of industrial goods. Chemicals (e.g., polyethylene flake itself) are being shipped in polyethylene film-lined fiber drums, in part to avoid contamination by the drum, and in part to prevent access of moisture. Tools and machines are transported and stored, wrapped in

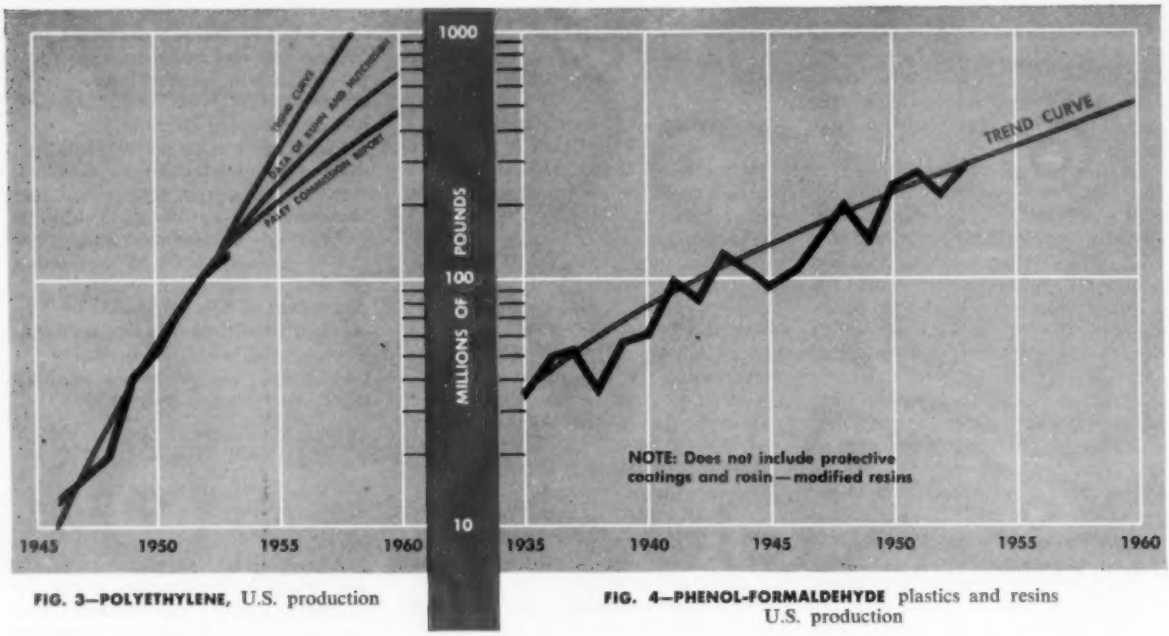


FIG. 3—POLYETHYLENE, U.S. production

FIG. 4—PHENOL-FORMALDEHYDE plastics and resins U.S. production

polyethylene film to prevent corrosion.

The growing use of polyethylene for specialty bottles is based on the material's flexibility and unbreakability. Bottle covers are still a relatively minor outlet for polyethylene, but a good future is seen in its use in lieu of cork and metal foil for bottle cap linings.

Polyethylene pipe finds growing application for corrosive fluids in the chemical industry, and in water transportation through acid soil. It is already in use for irrigation purposes, coal mine drainage and emergency water supply, and is beginning to invade the domestic field in competition with copper for cold water supply.

Application of polyethylene as insulating material is especially significant in long-distance communication cables.

There seems to be no limit to the variety of molded products manufactured of polyethylene. Illustrative are buckets, refrigerator pans, baby baths, etc. Interest is awakening in the use of polyethylene monofilament in conjunction with various textile fibers.

Growth outlook for polyethylene is extremely bright, as illustrated in Fig. 3. Most conservative view is taken by the Paley Commission report,[8] which looks to a 1960 production of only 500 million lb. (one billion lb. in 1975). Extrapolation of the Gompertz trend curve is shown but is not considered a reliable guide with so new a chemical which has, so far, been hampered by inability of production to keep up with demand. Current outlook is somewhat above Kuhn and Hutcheson's careful study made in 1951,[7] and it is expected that 1960 production will be just short of one billion lb.

8—Nylon

Nylon, primarily a polymerization product of adipic acid and hexamethylene diamine, is ultimately derived from petrochemicals (cyclohexane, butadiene, hydrogen cyanide). Its well-known use as textile fiber overshadows plastics applications, which deserve brief mention here.

The plastic is readily molded and, because of its good flow properties, is suitable for the manufacture of thin-sectioned articles. Its products are characterized by high impact strength, high-temperature tolerance, and good resistance to abrasion and to many chemicals.

Nylon monofilament finds extensive use in tooth brush bristles, surgical sutures, tennis strings, etc. Other uses include combs, unlubricated small bearings, small gears, etc. Nylon-coated electrical wire is useful at severe service conditions of abrasion and high temperature (an oxidizing tendency develops above 300° F.; the material is form-stable up to about 375° F. in the absence of load).

9—Fluorocarbons

Polymers of fluorinated ethylene were introduced commercially in 1943. They are marketed under a variety of trade names, of which probably the best known are "Kel-F" (monomer: $CClF{=}CF_2$) and "Teflon" (monomer: $CF_2{=}CF_2$).

The monomers in this group have their roots in petroleum-derived chemicals. Tetrafluoroethylene is produced from chloroform and hydrogen fluoride via pyrolysis of the intermediate monochlorodifluoromethane. Chlorotrifluoroethylene is the dechlorination product of trichlorotrifluoroethane.

Official national production figures for this group of plastics are not available. 1951 output has been estimated at 2,500,000 lb. There has been appreciable growth in the interim.

Plastics in this group offer unique properties which will ensure their increasing acceptance in significant volume in spite of high cost (up to $19/lb.). They also present formidable processing problems, which are being overcome. The chlorine-containing fluorocarbons are more readily molded than tetrafluoroethylene polymers, which must be processed by methods reminiscent of powder metallurgy and which require after-fabrication. In return, polytetrafluoroethylene offers higher temperature stability and retains its good properties up to 500° F., while the chlorinated fluorocarbons are limited to 390° F.

The outstanding characteristic of the fluorocarbons is their complete chemical inertness and zero moisture absorption. Molded products exhibit, in addition, high impact strength over a wide temperature range, resistance to

thermal shock, high compressive strength and good electrical properties.

Application of molded and extruded polyfluorocarbons is predominantly in the electrical and chemical process industries. In the latter field, uses include drum liners, pump packing, pipe, etc., in highly corrosive service. Electrical uses include insulation and wire coatings, condenser foil for corrosive conditions at extended temperatures, etc.

Dispersions of these polymers serve in chemically inert surface coatings. "Kel-F" polymer oils and waxes are used to plasticize molding powders derived from the same monomer. These oils and greases have lubricant qualities and are of interest where their chemical inertness is of value. Materials in this category also find interesting application where sticking must be prevented, as in bakery pans.

Thermosetting Resins

In this historically older category of plastics, we find materials which can be molded but once. Under the influence of high-temperature forming, they undergo an irreversible chemical reaction. Obviously, this means that useful product yield in the forming stage is lower than is the case with thermoplastics, where scrap can be recovered and reworked.

In 1953, thermosetting plastics, other than alkyds, were produced in the volume of 700 million lb., or 23% of the entire U. S. output of synthetic resins. This represents an increase of 260 million lb. over the 1948 output, but also demonstrates a decline in the relative importance of this category in the plastics industry as a whole. Thermosetting materials accounted for 31% of the entire resin production in 1948.

Among thermosetting resins, we discern two major categories:

(a) The alkyd resins, which are derived from polyesters of polybasic acids (mainly phthalic acid, also maleic acid and others) and polybasic alcohols (glycerol, pentaerythritol). In each case, the raw materials are largely products of petrochemical operations. However, alkyd resins find their principal application in the surface coating industry and their discussion is therefore outside the proper scope here.

(b) In the second big category are the plastics derived from aldehydes—mainly formaldehyde. Here, the main markets are found in the plastics industry. Surface coating applications, though certainly significant, take a secondary place.

Formaldehyde, which is the most important raw material common to this group of plastics, is the product of partial oxidation of methanol, most of which is today derived from hydrocarbon gases. An alternate source of formaldehyde is the direct partial oxidation of hydrocarbons.

The significance of the plastics market to this branch of the petrochemical industry is illustrated by the (estimated) distribution pattern for formaldehyde during 1953:[13]

	Formaldehyde lbs.	Consumption %
1—Phenolic resins (total)	280	23
2—Urea resins	245	20
3—Melamine resins	55	4.5
4—Pentaerythritol	230	19
5—Hexamethylene tetramine	220	18.5
6—Miscellaneous	170	14
Total	1200	100.0

Of this list, the first three items are used primarily for the production of plastics. Pentaerythritol's main outlet is in synthetic resins consumed by the paint and lacquer industries. Some hexamethylene tetramine is included in phenol-formaldehyde resin formulations.

A new group of thermosetting materials—the polyesters—shows indication of a very large eventual potential. Over 40 manufacturers are actively engaged or interested in this field.[14]

1—Phenol-Formaldehyde Resins and Cast Phenolics

These resins were introduced in 1909, the first wholly synthetic plastics. Over the years, they have maintained a position of prime importance and are still the most important of the thermosetting resins. Production of the unmodified resin in 1953 was nearly 300 million lb. Including modified forms, last year's output is estimated at 453 million lb.

Along with formaldehyde, phenol enters into the polymer of this group of thermosetting plastics. This intermediate, which is today produced by four different routes from benzene,[15] finds its largest market in the plastics industry. In 1951, phenolic resins consumed 232 million lb. of phenol, or 59.8% of total sales for this tar acid. It should be noted, however, that other outlets for phenol are growing at an even faster rate than its plastics products so that the 1951 share of the market taken by resins represents a decline in relative importance since 1945, when 69% of phenol's sales were accounted for by polymerizates.[16]

The greater portion of phenolic resins goes into molded and cast products. In the former type of application, the material must be compounded with plasticizer and filler. It is addition of the latter material in particular which makes phenolics so inexpensive and lends great versatility. For example, asbestos filler is used for high-temperature applications, fibrous cotton for high-impact plastics. Other extenders include wood flour, carbon, iron powder, barytes, etc., each of which is selected to impart some special property to the final molded product.

Outstanding general physical characteristics of phenolics include great hardness, rigidity, toughness and strength. They have heat resistance up to 300° F. (and higher in special formulations) and are poor heat conductors. Phenolics are not flammable. They are excellent electrical insulators and have a fairly good range of chemical resistance. They show good permanence in the presence of water.

Based on data by the U. S. Tariff Commission[1] the following 1953 distribution pattern of phenolics may be estimated:

End Use	Production Million lbs.	%
Molding Materials	113.0*	36.4
Bonding and adhesive for laminating	70.5	22.7
Coated and bonded abrasives	12.3	4.3
Friction materials	18.4	5.9
Thermal insulation	20.7	6.7
Plywood	17.8	5.7
Protective coating resins, unmodified and modified except by rosin	28.1	9.1
Resins for all other uses	28.7	9.2
Total	310.4	100.0

* Corrected for pure resin by assuming its content at 50%, the balance being fillers, plasticizers and extenders.

Of outstanding importance are the applications of phenolics in the electrical and electronic industries. Uses here range from production of telephone sets to circuit breakers, housings for television sets, motor rotors, etc.

Acid-resistance makes phenol-formaldehyde resins a useful construction material in solution of some chemical plant problems. Numerous household applications, such as electric iron handles, are typical of the products which may be based on phenol-formaldehyde resins. Laminates find increasing application for kitchen and store counter tops, wall coverings, etc. An interesting new development are gas-filled phenol-formaldehyde mircoballoons for blanketing oil tanks. Brake linings, clutch facings and use as binder for mineral wood in thermal insulation and for wood waste are important established and growing markets.

A specialty group are the cast phenolics which contain no filler or plasticizer. They are less workable, must

be cast and machined, and are more costly per unit volume than molded materials. But they share many of the other good qualities of phenolic resins described above, and offer a wider range of colors, including translucency and transparency. Cast phenolics find use in baby's toys, juke box housing parts, fountain pen bases, etc.

Three recent developments promise fruitful new markets:

(a) Shell molding offers a new cost-saving technique for mass production in foundries. This is still a minor outlet (15 million lb. per year) but optimistic estmates speak of a potential amounting to "several hundred million pounds per year."

(b) Techniques for metal-plating phenolics appearing in the offing should add significantly to the market for these plastics in ornamental parts.

(c) Growing knowledge is being acquired in the molding of large phenofic parts.

Over the years, phenol-formaldehyde resins have shown a good growth trend, though this has been more modest than in the case of polystyrene and vinyl resins, and subject to greater fluctuations. The production history of phenol-formaldehyde plastics, exclusive of resins used for protective coatings and of rosin-modified resins, and on the basis of estimated resin content, is traced in Fig. 4. Extrapolation of the Gompertz trend curve forecasts a 1960 production of 550 million lb.

2—Phenol-Furfural and Resorcinol-Formaldehyde Resins

Brief note must be made of the condensation products of phenol and furfural. These materials are compounded in a manner similar to that followed with phenol-formaldehyde resins, and the products of both resins exhibit comparable characteristics.

An outstanding property of phenol-furfural resins is the slowness with which they set below 320° F. Furthermore, they are considerably more fluid, prior to setting, than phenol-formaldehyde resins of like formulation. This combination of properties exhibited by phenol-furfural resins makes these materials particularly suitable for molding into long-draw and large-volume products.

Other tar acids, which may be synthesized from petroleum hydrocarbons, enter into plastics production. Among these might be mentioned the cresols (methyl phenols) and especially resorcinol (m-dihydroxy benzene). The latter compound is synthesized by caustic fusion of the disulfonated benzene derivative. Its condensation product with formaldehyde may be polymerized into an outstanding adhesive, used extensively in the production of plywood for exterior or maritime service and in other important bonding applications.

3—Aminoplasts (Urea- and Melamine-Formaldehyde)

With a 1953 output of 243 million lb., this is the second-largest group of thermosetting resins. Urea-formaldehyde resins were introduced in 1929 and the melamine plastics were first marketed 10 years later. The group of aminoplasts showed good growth during the early years of its acceptance, but rate of expansion has dropped off markedly since 1950.

The older member of the aminoplasts is almost wholly derived from petrochemical sources. The connection between formaldehyde and petroleum raw materials has been discussed above. Urea is synthesized from carbon dioxide and ammonia (80% of which was derived from natural gas during 1953). The route to melamine starts with ammonia and calcium cyanamide. This material, then, is only incidentally derived from hydrocarbon stock.

Urea-formaldehyde resins have proved attractive because of low cost coupled with their good physical properties which parallel those of phenoplasts in many respects. An important advantage is the wider range of colors which can be readily obtained with urea-derived plastics, including light pastels and even a certain degree of transparency and translucency (light-colored phenolics are a relatively recent development).

Finished urea plastics are characterized by very high dimensional stability and outstanding color fastness. Temperature is limited to 175° F. for prolonged exposure. Urea resins show good electrical resistance even under circumstances where phenolics lose their value as insulating material.

Materials in this category find application as molding powder (for production of lamp shades, buttons, portable radios, scale housings, etc.). Laminates are employed as light diffusing panels and are beginning to find use in counter tops. Urea-formaldehyde resins serve for adhesive purposes in the hardwood plywood industry. Other outlets include paper and textile treatment operations and production of low-temperature foundry cores.

Melamine-formaldehyde plastics share most of the properties of the ureas. They are more costly but have the important advantage of being able to withstand higher temperatures (up to 210° F.). The combination of stability near the temperature of boiling water, colorfulness, high surface hardness, and good chemical resistance make the melamine materials ideally suited for the production of plastic dishware (perhaps 14-18 million lb. last year).

Other relatively minor outlets for melamine plastics include buttons, hearing aids, distributor heads, etc. Some melamine-formaldehyde is used in the formulation of phenolic laminates, apparently an application of some promise. Like urea resins, the melamines are used for plywood bonding purposes and in the treatment of paper and textiles.[18]

Distribution of aminoplastics in 1953 was as follows:

	Millions of lbs.	%
Textile-treating and coating	30.7	12.6
Paper-treating and coating	21.3	8.8
Binding and adhesive for plywood	52.9	21.8
Other binding and adhesive	42.1	17.4
Protective-coating resins	29.7	12.2
All other (laminating, molding, etc.)*	65.9	27.2

* Includes filler for molding materials.

This is, at present, not a fast-growing group of resins. The only important expansion during the past three years has been in the categories of textile and paper treatment.

4—Polyesters

In polyesters, we have a new family of thermosetting binders for reinforced plastics. The composition of the resin itself may be varied over wide limits, and different reinforcing materials may be employed (although glass fiber is, at present, most common). It thus becomes possible to obtain relatively inexpensive (40-60¢/lb.) plastics which may be "custom-tailored" to the end products' needs. Some valuable properties attainable in the material are unique among presently commercial plastics.

The chemical make-up and petrochemical background of this group may be illustrated by reference to raw materials used in the production of a "typical" polyester:[17]

Raw Material	(Hydrocarbon Source)	Pounds of Raw Material Used
Phthalic Anhydride	(o-xylene or naphthalene)	20
Maleic Anhydride	(Benzene)	20
Styrene*	(Benzene and ethylene)	30
Glycol	(Ethylene)	40

* Butadiene may be used in lieu of styrene

Polyesters were first introduced in 1942 but did not become available for civilian uses until 1946. Following a short incubation period, the market for

this group of plastics has shown a very strong growth trend and expansion is now at the rate of 30-40% per year. The following year-by-year statistics for polyester resins are from the Society of the Plastics Industry:

1946	1.5	million lbs.
1947	0.8	" "
1948	1.8	" "
1949	4.5	" "
1950	8.5	" "
1951	14.0	" "
1952	19.0	" "
1953	26.0	" "
1954	35.0	" " (est.)

Reinforced polyesters are characterized by outstanding resistance to impact and abrasion. Very strong and rigid laminates or molding materials may be formulated; good surface hardness and wide chemical resistance may be obtained. Other valuable properties include good dielectric properties, high colorability, ranging from a water-white transparent product to opaque laminates in many color shades. Heat resistance up to 500° F. may be obtained and polyesters so formulated are in commercial use today. Extremely important is the adaptability of reinforced polyesters to the forming of large parts.

The most spectacular use for this product is its substitution for steel in automobile bodies (e.g., in Chevrolet's "Corvette," some of Kaiser's sports models). Already more established are the uses for polyesters in the boat industry, in the production of highway signs, safety helmets, etc. Corrugated translucent reinforced plastics for glazing and structural use have made progress in the construction field. There is promise in the use of flat sheets of reinforced polyesters for printed circuit work in electronics.

Other developing uses include pipe, station wagon components, tank and truck construction, refrigerator applications, and metal stamping and fabricating operations. Reinforced polyesters of high flame resistance have appeared on the market and promise a wide range of usefulness.

Here, then, is a new type of resin which greatly boosts the outlook for petrochemical sales to the plastics industry. Its stage of development is still too early to permit more than qualitative forecast at this time.

Miscellaneous Plastics

In the foregoing sections we have had a look at the branches of the plastics industry which offer the greatest actual or potential markets to petrochemicals. The list of products discussed is, however, by no means complete, nor can an exhaustive presentation of this immensely versatile field be given in this place.

To further round out the picture, brief reference must be had here to some other commercial resins which can be traced, in part or in whole, to petrochemical origins. Among them we find the large group of alkyds (derived from phthalic or maleic anhydride and polyhydric alcohols, and frequently modified by styrene) which find almost exclusive use in surface coating applications. Produced in relatively small volume are polyisobutylene plastics, anilin-formaldehyde resins, urea-thiourea resins, various maleic anhydride condensation products (with rosin, terpenes, etc.), dichlorostyrene polymers. This interesting group of silicones uses alkyl chlorides (e.g. methyl chloride) as one raw material, as do also the various cellulose ethers (of which we have only considered ethyl cellulose).

Plastics are indeed growing rapidly, and the laboratory curiosity of today may be the large-scale product of five years hence. Its versatility makes the plastics industry the ideal marketing ground for a wide range of petroleum-derived chemicals.

Plasticizers

Second in importance to the consumption of petrochemical monomers in the plastics industry is the use of plasticizers. Their growth is, of course, directly related to the expansion of the consumer resin, be it vinyls, phenol-formaldehyde, cellulose acetate or any other polymeric product.

It is difficult to say just where the solvents end and plasticizers start. Both groups fill similar functions and they are chemically related. The division is made somewhat arbitrarily on the basis of volatility—plasticizers having the lower volatility of the two functional categories.

By far the most important group of plasticizers are the phthalates. Their production has recovered from a slump which took place between 1944 and 1946, and they are again on the rise. In second place are organic phosphates. Here, only the alcohol radical of the ester can be derived from petroleum sources. The same limitation applies in the case of the third- and fourth-largest families of plasticizers—stearates and oleates. The two last-named groups are of relatively recent application and they showed good growth until 1950. Together they constitute less than 10% of all plasticizers produced. Specialty plasticizers include sulfonamides, orthonitrobiphenyl, adipic esters, and a host of others which, in sum, make up some 25% of the whole plasticizer market.

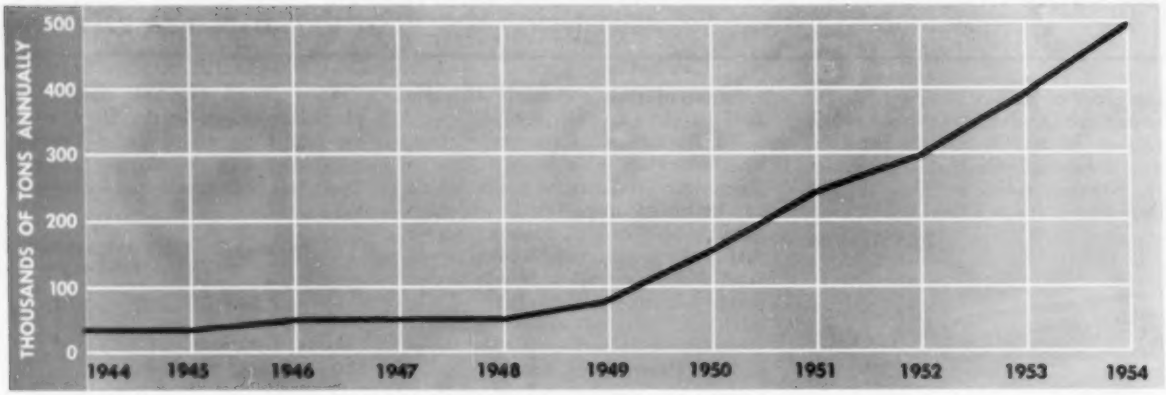
Most recent available data[19] on plasticizer output in the U. S. cover the year 1952, which was a low-production year in the plastics industry. There has been substantial increase in 1953.

Chemical	1952 Production (Million pounds)
Summary:	
All Plasticizers	267.7
Cyclic Plasticizers	194.3
Acyclic Plasticizers	73.4
Major Individual Plasticizers:	
Phosphoric Acid Esters:	
Tricresyl phosphate	18.0
Triphenyl phosphate	5.6
Phthalic Anhydride Esters:	
Dibutyl phthalate	17.9
Diethyl phthalate	12.1
Dioctyl phthalate	86.9
Adipic acid esters	7.3
Stearic acid esters	16.4
Oleic acid esters	7.3
Acyclic Phosphoric acid esters	8.9

In all of these esters, petrochemicals have a part, either for the production of the alcohol radical or, as in the case of phthalates and adipates, for both the alcohol and acid part of the plasticizer.

References

(1) U.S. Tariff Commission, Facts for Industry, Preliminary Report for 1953 (released March 22, 1954).
(2) *Modern Plastics*, January 1954, p. 70.
(3) Manufacturing Chemists' Association, "Chemical Facts and Figures," 3rd ed. (1950)
(4) Schoene, D. L., "New Horizons in Rigid Thermoplastics," Paper presented to 1952 Plastics Conference, Fifth National Plastics Exposition.
(5) "A Panel Discussion on High-Impact Polystyrene Plastics," Society of the Plastics Industry meeting held at Manchester, Vt. October 16-17, 1952.
(6) *Chemical Week*, April 3, 1954, p. 52.
(7) Kuhn, W. E., and Hutchinson, J. W., PETROLEUM PROCESSING, October, November, 1951.
(8) "Resources for Freedom," Report to the President by The President's Materials Policy Commission, vol. IV, "The Promise of Technology," June 1952.
(9) Riddle, E. H., *Chem. Eng. News*, 31, 2854 ff (July 13, 1953).
(10) Kaye, S. L. "The Production and Properties of Plastics," International Textbook Co., Scranton, Pa. (1947).
(11) Naugatuck Chemical Division, "Marvinol Vinyl Resins," current ed.
(12) *Chem. Eng. News*, March 29, 1954, p. 1276.
(13) Aalto, T. R., *Chem. Eng. News*, 32, 1398 ff. (April 5, 1954).
(14) *Business Week*, April 10, 1954, p. 105.
(15) Sherwood, P. W., PETROLEUM PROCESSING, September, October, November, 1953.
(16) Nieuwenhuis, H. K., *Chemical Week*, May 2, 1953, pp. 30 ff.
(17) *Chem. Eng. News*, October 5, 1953, p. 4150.
(18) "Plastics, The Story of an Industry," 5th revised ed., published by the Society of the Plastics Industry.
(19) U.S. Tariff Commission, "Synthetic Organic Chemicals, U.S. Production and Sales," 1952.



SMALL BUT GROWING is the output of sulfur from petroleum since the first recovery plant went into operation in 1944

PETROCHEMICALS — TOMORROW

The Outlook for... Sulfur

By NORMAN C. UPDEGRAFF, Asst. Technical Director
The Girdler Co., Louisville, Ky.

DUE to the high sulfur content of many crude oils and natural gases, a number of petroleum processers have found themselves in the sulfur production business as a necessary adjunct to their hydrocarbon operations. This sulfur is found in various forms in crude oil, but is generally converted to either hydrogen sulfide or sulfur dioxide in the course of the operations. The predominant form in natural gas is hydrogen sulfide.

By-product recovery of sulfur from the hydrogen sulfide produced in natural gas or petroleum operations is a comparatively new process in this country. The first U.S. commercial installation was started at McKamie, Ark., by Southern Acid and Sulphur Co. (since acquired by Mathieson Chemical Corp.) just 10 years ago, in 1944. This unit produced elementary sulfur from hydrogen sulfide removed from natural gas by McKamie Gas Cleaning Co.

The first U.S. sulfur recovery plant to use hydrogen sulfide obtained from refinery gas was placed in operation in 1948 by Hancock Chemical Co. near Los Angeles. This unit gathered hydrogen sulfide from two refineries owned by Richfield Oil Corp. and The Texas Co. Later on hydrogen sulfide from Associated Oil Co. and General Petroleum Corp. was added to the raw material supply.

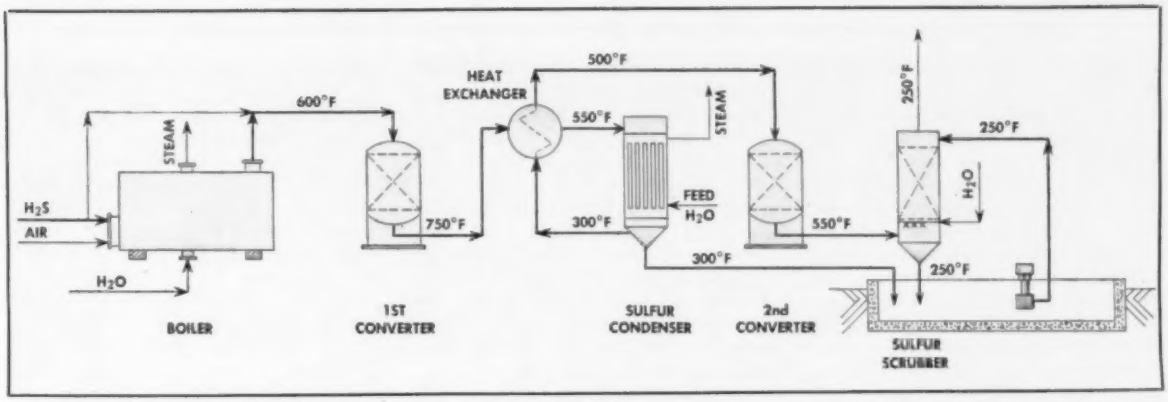
Since these early plants were started, a large number of units have been completed obtaining hydrogen sulfide from natural gas and refinery operations. At present the petroleum industry has become a net producer of sulfur instead of a consumer. Preliminary estimates for 1953 published in March by *Chemical Engineering* placed the 1953 U.S. production of sulfur from such units at 345,000 long tons. Compared with a U.S. production of 5,155,000 tons by the Frasch process and 930,000 tons from pyrites and other miscellaneous sources, this is not a very large percentage but its importance is increasing annually.

The increase in sulfur recovery operations may be attributed to a combination of factors. The primary cause is that the market price of sulfur has increased from $16-18 per long ton to $26-28 in the past several years due to the increased costs of mining. This higher price has made the production of sulfur from hydrogen sulfide more feasible economically even in relatively small quantities. In addition, in some instances the location of the sulfur recovery plants with respect to the markets results in a favorable freight rate advantage. Thus it is now possible to produce sulfur from hydrogen sulfide which may be sold competitively with mined sulfur, whereas prior to this price increase the advantage was so marginal that it was generally attractive only to sulfur users.

Another important factor has been the increased consumption of natural gas and the conservation measures taken by the various states to eliminate the previous practice of flaring sour gases. The sales value of the by-product sulfur has helped offset the cost of desulfurizing these gases for pipeline purposes.

Secondary reasons which have helped promote this relatively new source of sulfur have been largely negative ones. During the period of sulfur allocations starting in 1951, companies that built new sulfur plants could absorb their full production without reducing their allocation, thus providing them with an assured source of sulfur when it was in tight supply. Another factor has been the increased enactment and enforcement of anti-pollution legislation. This was one of the primary purposes for building the first refinery gas sulfur recovery plant, and several other installations have been made since then in which control of air pollution was a large factor. In general, these are units based on refinery operations which are more likely to be near population centers than natural gas operations.

In favor of the natural gas operations is the larger quantities of hydrogen sulfide which may be processed at any given site. Many of the new gas fields have hydrogen sulfide concentrations as high as 30 to 50% by volume of gas produced. Whereas the capacity of the refinery units generally range from 30 to 100 tons per day, the natural gas installations range in size up to the 300 ton per day plant operated by Texas Gulf Sulphur Co. at



2-STAGE SULFUR RECOVERY UNIT, typical of the type designed for a feed gas containing 90% hydrogen sulfide

Worland, Wyo. These larger units are cheaper to operate per ton of product and thus can generally produce sulfur at lower cost.

The producers of sulfur from hydrogen sulfide are varied. They include refiners, chemical companies, natural gas operators and sulfur mining companies such as Freeport Sulphur Co. and Texas Gulf Sulphur Co. Hydrogen sulfide may be either converted to sulfur directly by the refiner or natural gas operator or sold "over the fence" to another company which owns and operates the recovery unit.

In natural gas operations the sulfur producer may also operate the gas purification plant as well as the sulfur recovery unit. This is the case in Worland, Wyo., where Texas Gulf Sulphur Co. operates the largest recovery unit in the country—if not in the world. Here Pure Oil Co. produces the field and pipes natural gas containing 30% hydrogen sulfide to Texas Gulf Sulphur from their natural gasoline plant. The latter company purifies the gas and pipes it back to Pure for further processing. Texas Gulf Sulphur then converts the hydrogen sulfide to sulfur and markets the product.

Methods of shipping and storing sulfur vary appreciably with the operator. In many instances the liquid sulfur is pumped directly into insulated tank trucks which carry it to the ultimate users. This is the most convenient way of handling moderate quantities. At least two installations solidify the sulfur on belts or drums and produce flakes that can be handled as loose bulk material. Others pump the sulfur to vats and solidify it in a manner similar to that used at the mines. The sulfur is broken up by blasting and shipped in bulk form.

The sulfur recovery process, although relatively new to this country, is based on old art. The original process is credited to Carl Friedrich Claus of London, who obtained a British patent in 1882 and U.S. patents in 1886. The Claus process comprised the catalytic reaction of air with hydrogen sulfide at elevated temperature as follows:

$$H_2S + 1/2O_2 = S + H_2O$$

This overall reaction is highly exothermic and as a result the early plants were limited by their ability to dissipate heat properly. Accordingly, I. G. Farbenindustrie engineers modified the process by splitting it into two reactions:

$$H_2S + 3/2O_2 = SO_2 + H_2O \quad (1)$$

$$SO_2 + 2H_2S = 3S + 2H_2O \quad (2)$$

Reaction 1 was carried out in a combustion chamber where sufficient air was added to burn one third of the total hydrogen sulfide to sulfur dioxide. Heat was removed by generating steam in a waste heat boiler. The second reaction was carried out over a catalyst, followed by heat and sulfur removal operations. Generally, a two stage operation was employed to increase the percentage yield of sulfur from hydrogen sulfide. All of the sulfur recovery units employing hydrogen sulfide in this country are based on this modified Claus process and differ only in the means of heat and sulfur removal and in the number of stages employed.

A typical flow scheme is shown above for a two stage plant employing a feed gas containing about 90% hydrogen sulfide.

Reaction 1 takes place in the combustion chamber of a fire-tube boiler, where approximately one-third of the hydrogen sulfide is burned to sulfur dioxide and steam is generated in proportion to the hydrogen sulfide burned. The amount of steam generated may vary from one to two pounds per pound of sulfur recovered, depending on the composition of the gas mixture, pressure of steam desired, and boiler efficiency. If more than one-third of the feed gas is introduced into the boiler, some sulfur may be formed according to Reaction 2. This reaction is also exothermic and will result in the generation of additional steam. However, if hydrocarbons are present in the hydrogen sulfide-bearing gas, it is important that complete combustion of those introduced into the boiler takes place there to avoid carbon deposition in the converters. In this case, not more than one-third of the gases should be burned in the boiler with the correct quantity of air for complete combustion.

Following the steam boiler, the gases pass through the first converter, where most of Reaction 2 takes place and a gas temperature rise results. It is estimated that 70-80% of the sulfur recovered is formed in the first stage and the balance in the second, after intermediate product removal. The catalyst employed is activated bauxite, which has an indefinite life, being subject only to mechanical failure. The converters are carbon steel vessels lined with a suitable sulfur-resistant cement.

In order to remove the sulfur formed in the first converter the gases are cooled to approximately 300° F. and the sulfur condensed in a waste heat boiler. A heat exchanger is employed to cool the gases entering this condenser and reheat them before entering the second converter. Final cooling and condensation after the second converter take place in a carbon steel, Raschig ring-packed scrubber where the hot gases pass countercurrent to liquid sulfur. The circulating sulfur, heated in the scrubber, returns to the sulfur tank carrying with it the newly formed sulfur. The tail gases consist largely of nitrogen, water vapor, carbon dioxide (if present originally), and small percentages of unreacted hydrogen sulfide and sulfur dioxide.

The concrete sulfur tank not only serves as a sump for the sulfur circulating and product pumps but also as surge storage space. The product sulfur may be pumped to vats for solid storage, to tank cars or trucks for

shipment, or directly to a subsequent processing operation such as a sulfuric acid plant. The pumps are vertical immersed-type centrifugal pumps especially designed for sulfur service. Liquid sulfur is held between 250° F. and 300° F. at all times to avoid the higher viscosity ranges above and below these temperatures, and piping is jacketed with 30 psig. steam to keep the sulfur in a free flowing state. Steam coils are supplied in the sulfur storage tank to provide heat in case of shutdowns or excessive cooling from other conditions.

Direct recovery processes are not too common, although some installations have been made in which the hydrogen sulfide is reacted directly, without prior separation from the gas stream.

One scheme for this was employed in Iran in which air was introduced directly into the gas stream. The plant consisted of a preheater in which the temperature of the gas was raised up to about 570° F., a mixing chamber where the necessary air was introduced, a catalyst-filled reaction chamber, and a glass-wool sulfur fog extractor. By this operation the hydrogen sulfide content was reduced from 12% to 1.5-2% by volume. Two serious objections could be raised against this method of hydrogen sulfide removal: (1) a second plant of the amine purification type was necessary to complete the desulfurization, and (2) the method loaded the hydrocarbon stream with about 25% by volume of nitrogen.

A modification of this system has been developed by Jefferson Lake Sulfur Co. It consists of burning a portion of the sulfur produced and introducing the resulting sulfur dioxide into the hydrogen sulfide-bearing stream. This scheme has the advantage of permitting lower operating temperatures, which avoids cracking or oxidation of the hydrocarbons. Unless a separation plant is employed to remove the nitrogen from the sulfur burner gases, however, the dilution effect of the nitrogen on the hydrocarbon stream is still present. Also, it is doubtful that the degree of sulfur removal can compete with that attained by more conventional gas purification processes.

Other schemes for direct reaction of hydrogen sulfide in the hydrocarbon streams have been proposed and tested but at present no commercial installations of these are known.

In general, it would appear that direct recovery processes such as described above will have a limited application; however, improved technology and increased discoveries of high hydrogen sulfide content gases may cause these processes to be more important factors in future projects. Offsetting the various disadvantages of these processes is the expected reduction of investment and operating costs as compared with the use of separate units for gas purification and sulfur recovery.

The future outlook for sulfur, according to "Resources for Freedom," the report of the President's Materials Policy Commission, is that total consumption by 1975 is expected to be double what it was in 1950. With the decrease of our known high grade mineral reserves this demand will undoubtedly place a larger burden on by-product sulfur and marginal mineral deposits which are not economical to produce at current market prices.

It is difficult at this time to predict what sulfur deposits may be discovered in the next several years and what techniques may be developed for working them. For example the problems connected with working off-shore sulfur wells are appreciably greater than those encountered in oil production. However, at least one sulfur company has announced that it has developed the necessary know-how to do this if the market price justifies it.

In spite of uncertainty of future sulfur mining activities, it appears safe to predict that the production of sulfur from hydrogen sulfide will increase at a rate at least as fast as it has in the past ten years—and probably faster.

In the first place the increased use of high sulfur crude oils together with tighter regulations on atmospheric pollution will undoubtedly cause more refineries to install sulfur recovery equipment. Even when such an operation may not be attractive economically it is good public relations to do so, and may even be compulsory for continued operation.

Secondly, more and more of the natural gas fields being opened up in the United States and Canada have been found to have a high hydrogen sulfide content, some as much as 50%. In order to use this gas for any commercial purpose it is imperative that the hydrogen sulfide be removed.

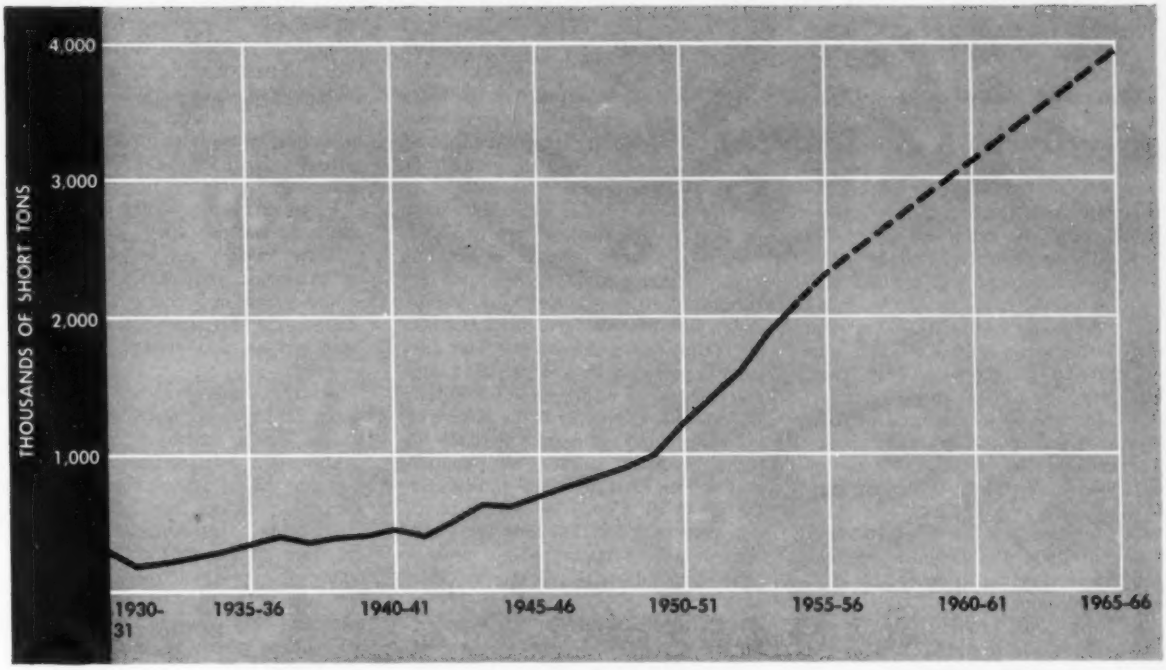
A third factor that probably is not too significant at present is that the purity of the sulfur recovered from hydrogen sulfide is higher that that obtained from some of the newer deposits being worked. Thus this material can be sold at top quality prices without further purification.

Aside from these factors it is probable that the recovery of sulfur from hydrogen sulfide may get a boost from future improvements in processes and apparatus. It is entirely possible that satisfactory processes may be developed which can recover hydrogen sulfide directly from hydrocarbon streams without the various disadvantages outlined above for the presently used methods. Thus, plants may be economically feasible which were previously handicapped by transportation charges or the fact that they were too small.

In general, it can be said that the first ten years have proved that the production of sulfur from petroleum operations is technically and economically sound. It is apparent that the process is here to stay and future expansion is expected to accelerate at a faster rate than production by mining techniques.

Meet the Author

Norman C. Updegraff, Assistant Technical Director, Gas Processes Division, The Girdler Co., Louisville, Ky., was graduated from Harvard in 1940 with an A.B. degree in engineering sciences. After a short spell of development work with General Foods he joined du Pont in 1942, where he worked as a production supervisor in Neoprene manufacture. He has been with Girdler since 1946, specializing in process design of plants for the production, purification and use of various industrial gases. He is co-author of the "Carbon Dioxide" and "Hydrogen" sections of the Encyclopedia of Chemical Technology, as well as miscellaneous papers on the production and purification of various industrial gases and the recovery of elemental sulfur. He has been active in local section activities of the American Institute of Chemical Engineers and American Chemical Society and is a member of the National Association of Corrosion Engineers and the Harvard Engineering Society.



NITROGEN-FOR-FERTILIZER—past demand and future outlook*

PETROCHEMICALS — TOMORROW

The Outlook for... Fertilizer

By W. R. ALLSTETTER, Vice President and E. C. KAPUSTA, Chemical Engineer
The National Fertilizer Assn., Washington, D.C.

THE importance of nitrogen-containing fertilizers in agriculture has been growing rapidly during the last two decades. During that period, the consumption of nitrogen in fertilizers has increased nearly 600%—from 275,000 tons in 1933-34 to an estimated 1,900,000 tons in 1953-54.

In addition, some 800,000 tons of nitrogen were consumed for industrial and military needs during 1953-54. Of this 2,700,000 tons some 60% was produced from natural gas.

In the early years of the fertilizer industry, up to the turn of the present century, natural organic products were our chief source of fertilizer nitrogen. These were replaced in turn by sodium nitrate from Chile and ammonium sulfate from the by-product coke oven industry. These materials for many years continued to furnish the major portion of our requirements.

Synthetic ammonia has emerged as the dominant source of fertilizer nitrogen in the past decade, however, largely as a result of the tremendous expansion in production which took place during the war years.

Today it is the key material in the manufacture of nitrogen fertilizers and chemicals. Ammonia is converted to nitric acid, which in turn, when neutralized with more ammonia, results in ammonia nitrate. Similarly, reaction of ammonia with sulfuric or phosphoric acids provides us with ammonium sulfate or phosphates. Urea is made by combining ammonia with carbon dioxide. Liquid forms are made by dissolving appropriate quantities of ammonia and ammonium nitrate or urea in water.

Synthetic ammonia is made by catalytically reacting nitrogen and hydrogen. In the past few years reforming and partial oxidation of natural gas have replaced almost entirely the coke-water gas method of hydrogen preparation. Natural gas has thus become the prime source of hydrogen for ammonia synthesis. Other sources of hydrogen include by-product hydrogen from chlorine cells and petroleum refinery gases. According to reports some of the newer ammonia plants will be provided with means of utilizing petroleum products such as bunker C oil as sources of hydrogen.

One of the earliest nitrogen fixation plants built in this country was at Belle, W. Va., completed by du Pont in 1926 and based on coal. Allied Chemical & Dye Corp. brought in a plant based on coal (since converted to gas) at Hopewell, Va., in 1928. Shell Chemical completed a plant at

* Historical data for 1930-1953 supplied by The National Fertilizer Assn.; predictions to 1966 received from J. R. Riley, Jr., vice president of Spencer Chemical Co.

Pittsburg, Calif., in 1931, in which natural gas supplied both feedstock and power.

Substantial expansion in synthetic nitrogen production capacity was called for in early 1951 by the U. S. Department of Agriculture as part of the Korean mobilization. Secretary Brannan announced that farmers would need an estimated 2,185,000 tons of nitrogen in fertilizer by 1955. This announcement was greeted with surprise by the industry and by many professional agriculturists. They had seen farmers use only 1,005,000 tons of nitrogen in the preceding year. USDA pulled out all stops, however, in its drive to have a defense production goal set up which would assure the farmers the 2,185,000 tons of nitrogen in fertilizer. With the support of farm organizations and farm state Congressmen, Secretary Brannan prevailed upon the Defense Production Administration to accept his estimated requirements.

In order to provide this much nitrogen for farmers the DPA established a domestic production goal of 2,930,000 tons. This was the amount which, together with some imports, was considered necessary to supply the 1955 needs of agriculture, industry and the military.

It now appears this production goal will be met. It also appears possible that farmers will use the projected 2,185,000 tons of nitrogen in the form of fertilizers. However, the potential supply available to farmers is expected to exceed this amount by perhaps as much as 15%.

The causes of this expected excess of supply over demand are two-fold. One is the large increase in net imports of commercial nitrogenous fertilizers (fertilizers carry no import duty). Imports averaged about 140,000 short tons nitrogen basis per year during the period from 1948 to 1951, and increased to an estimated 400,000 tons in 1953-54. The other is the failure of industrial and military demand to reach predicted levels. This situation may continue for some time since DPA has set a new domestic production goal of 3,500,000 tons for 1957. Assuming imports at about present levels and industrial and military take of 800,000 to 900,000 tons, 2.9 to 3 million tons would be left for agriculture.

Predicting future fertilizer usage has the experts pretty well stumped. Although USDA 1951 estimates as to 1955 needs will probably prove to be remarkably close to consumption, these estimates were actually based on the amount of nitrogen fertilizer that would be needed to carry the food requirements of the U.S. and its allies under emergency conditions. They were never intended as consumption estimates. Consumption estimates of nitrogen fertilizer have been almost uniformly low.

Farmers have recently confounded the experts with their demands for fertilizer. For years it was accepted as axiomatic that fertilizer demand would move up or down with farm income. On this subject treatises have been written and elaborate formulae evolved.

But the relationship began to break down in 1947. As farm income then turned down, fertilizer consumption continued to climb. This was at first explained as the satisfaction of pent-up wartime demand. But in 1954 that explanation hardly suffices. Now with net farm income in 1953 about 24% below the post-war peak in 1947, fertilizer consumption continues to move up. Nitrogen still shows a lot of market potential as a fertilizer component.

Thus it becomes very difficult to make any firm quantitative predictions as to future fertilizer nitrogen use. That the direction is up seems to be beyond question. The reason that it is up is that the proper use of nitrogen-containing fertilizer is a tremendously profitable practice. Fertilizer can raise yields, cut unit production costs and even double or triple per-acre profits. As long as it is profitable to use fertilizer the market will expand. Barring a disastrous collapse of farm prices, increased fertilizer use will continue to be profitable.

Potential increases in the usage of nitrogen fertilizer are very large.

Our corn crop alone is removing from the soil almost as much nitrogen as is consumed on all crops in the United States. Under proper farm management conditions it would be profitable to use considerably more than 2 million tons of nitrogen on corn alone and this would be true even if farmers curtailed total acreage enough to offset increased yields per acre.

Figures almost as startling apply to other crops such as wheat and cotton.

Considering all these factors, most observers believe that although there will be more than enough nitrogen fertilizer to satisfy farmer demand for the next few years, demand will continue going up. More new plants will be needed to meet demand at some future date—but the writers know of no method by which this date can be reliably estimated.

Meet the Authors

Mr. Allstetter

W. R. Allstetter has served as vice president of The National Fertilizer Assn. since April, 1952. He came to the NFA from the U. S. Department of Agriculture, where he had served as Deputy Director of the Office of Materials and Facilities in charge of fertilizers and agricultural chemical programs.

He is a graduate of Swarthmore College, where he specialized in chemistry and physics. His experience includes 11 years with the USDA, 4 years with the Army Corps of Engineers during World War II, and several years with a fertilizer producing company on the Pacific Coast.

Dr. Kapusta

Edwin C. Kapusta has been with The National Fertilizer Association, serving as its chemical engineer, since July, 1951. He is a graduate of Rensselaer Polytechnic Institute, was awarded his master's degree from Worcester Polytechnic Institute and his Ph.D. in chemical engineering from Iowa State College. He served in the Naval Reserve during 1945-46 and was on the laboratory staff of the American Cyanamid Co. at Stamford, Conn., from July, 1947 to Sept., 1948.

Dr. Kapusta is in charge of NFA's work in the field of technological research involving liaison between NFA, the Tennessee Valley Authority, and other government agencies.

Synthetic Ammonia Plants in the U.S.[1]

Company and Plant Location	—Status—		—Raw Materials—			—Nitrogen-Containing Products—				
	Operating	Proposed or Building	Nat. Gas	Coal	Other[2]	NH_3	Amm. Nitrate	Amm. Sulfate	Urea	Other[3]
Alabama By-Products, Birmingham, Ala.	...	x	...	...	x	x	...	...	...	...
Allied Chemical & Dye Corp., La Platte, Neb.	x	...	x	...	...	x	...	...	x	...
Allied Chemical & Dye Corp., Hopewell, Va.	x	...	x	...	...	x	x	...	...	x
Allied Chemical & Dye Corp., South Point, O.	x	...	x	...	...	x	...	...	x	x
American Cyanamid Co., Avondale, La.	x	...	x	...	...	x	...	x	x	...
Ammonia Chemical Corp., Oleander, Calif.	...	x	x	...	...	x	...	...	...	...
Atlantic Refining Co., Philadelphia, Pa.	x	...	x	...	(4)	x	...	...	...	...
Atlas Powder Co., Atlas, Mo.	...	x	x	...	...	x	...	...	...	...
Brea Chemicals, Inc., Brea, Calif.	x	x	x	...	...	x	x	...	...	...
Chillicothe Petrochemicals, Inc., Chillicothe, Texas	...	x	x	...	...	x	...	...	x	...
Columbia River Chemicals, Inc., Pasco, Wash.	...	x	...	...	(5)	x	...	x	x	...
Columbia-Southern Chemical Co., Natrium, W. Va.	...	x	...	...	x	x	...	...	...	...
Commercial Solvents Corp., Sterlington, La.	x	...	x	...	...	x	x	...	...	...
Cooperative Farm Chemicals, Lawrence, Kans.	...	x	x	...	...	x	x	...	...	...
Deere & Co., Pryor, Okla.	...	x	x	...	...	x	...	...	x	...
Delta Gas Chemical Corp., Buras, La.	...	x	x	...	...	x	...	...	...	...
Dow Chemical Co., Freeport, Texas	x	x	...	...	x	x	...	...	...	...
Dow Chemical Co., Pittsburg, Calif.	x	...	...	...	x	x	...	...	...	...
E. I. du Pont, Niagara Falls, N. Y.	x	...	...	...	x	x	...	...	...	...
E. I. du Pont, Belle, W. Va.	x	...	...	x	...	x	...	...	x	x
General Petroleum Corp., Torrance, Calif.	x	...	...	...	(6)	...	...	x	...	...
Grace Chemical Co., Woodstock, Tenn.	...	x	x	...	...	x	...	...	x	...
Hercules Powder Co., Hercules, Calif.	x	...	...	...	x	x	...	...	...	...
Hercules Powder Co., Louisiana, Mo.	x	...	x	...	...	x	...	...	...	...
Hooker Electrochemical Co., Tacoma, Wash.	x	...	...	...	x	x	...	...	...	...
Lange Bros., St. Louis, Mo.	...	x	x	...	...	x	...	...	...	x
Lion Oil Co., El Dorado, Ark.	x	...	x	...	...	x	x	x	...	...
Lion Oil Co., Luling, La.	x	...	x	...	...	x	x	...	...	...
Mathieson Chemical Corp., Lake Charles, La.	x	...	x	...	...	x	...	...	...	...
Mathieson Chemical Corp., Niagara Falls, N. Y.	x	...	...	...	x	x	...	...	...	...
Mathieson Chemical Corp., Morgantown, W. Va.	x	...	...	x	...	x	...	...	...	...
Midland Ammonia Co., Midland, Mich.	x	...	...	...	x	x	...	...	...	...
Mississippi Chem. Corp., Yazoo City, Miss.	x	...	x	...	...	x	x	...	...	...
Mississippi River Fuel Corp., Crystal City, Mo.	...	x	x	...	...	x	x	...	...	...
National Distillers Products Corp., Tuscola, Ill.	...	x	...	...	(7)	x	x	...	...	x
Northern Chemical Industries, Inc., Searsport, Maine	...	x	...	...	(5)	x	x	...	...	x
Pennsylvania Salt Mfg. Co., Wyandotte, Mich.	x	...	...	...	x	x	...	...	...	...
Phillips Chemical Co., Etter, Texas	x	...	x	...	...	x	x	...	...	x
Phillips Chemical Co., Pasadena, Texas	x	...	x	...	...	x	...	x	...	...
Salt Lake City Chem. Co., Salt Lake City, Utah	...	x	x	...	...	x	x	...	...	...
San Jacinto Chemical Corp., Houston, Texas	x	...	x	...	...	x	...	...	...	...
Shell Chemical Corp., Pittsburg, Calif.	x	...	x	...	...	x	...	x	...	...
Shell Chemical Corp., Ventura, Calif.	x	...	x	...	...	x	...	...	...	...
Spencer Chemical Co., Pittsburg, Kans.	x	...	x	...	...	x	x	...	...	x
Spencer Chemical Co., Henderson, Ky.	x	...	x	...	...	x	x	...	...	x
Spencer Chemical Co., Vicksburg, Miss.	x	...	x	...	...	x	...	...	...	x
Standard Oil Co. (Ohio), N. W. Ohio	...	x	x	...	(4)	x	...	...	x	x
Tennessee Valley Authority, Wilson Dam, Ala.	x	...	x	...	...	x	x	...	...	...
Union Oil Co. of Calif., Wilmington, Calif.	x	...	...	...	(6)	...	...	x	...	...
United Chemical Co., Timpson, Texas	...	x	x	...	...	x	...	...	x	...
Utah Chemical Co., Mt. Pleasant, Utah	...	x	x	...	...	x	x	...	...	x
Westvaco Chlor-Alkali Div. of Food Machinery & Chem. Corp., Charleston, W. Va.	x	x	x	...	x	x	...	...	...	...

(1) For more details on the petrochemical plants in this list, see the 1954 Petrochemical Directory in this issue, pg. 1417.
(2) Other raw materials, where not otherwise identified, are usually by-product gases from electrolytic cells.
(3) Other products include ammonia solutions, nitric acid, sodium nitrate, nitrophosphate.
(4) By-product hydrogen from catalytic reforming operations in the refinery.
(5) Bunker C fuel oil.
(6) Refinery wastes.
(7) By-product hydrogen from ethane cracking operations in the adjacent plant of National Petrochemicals.

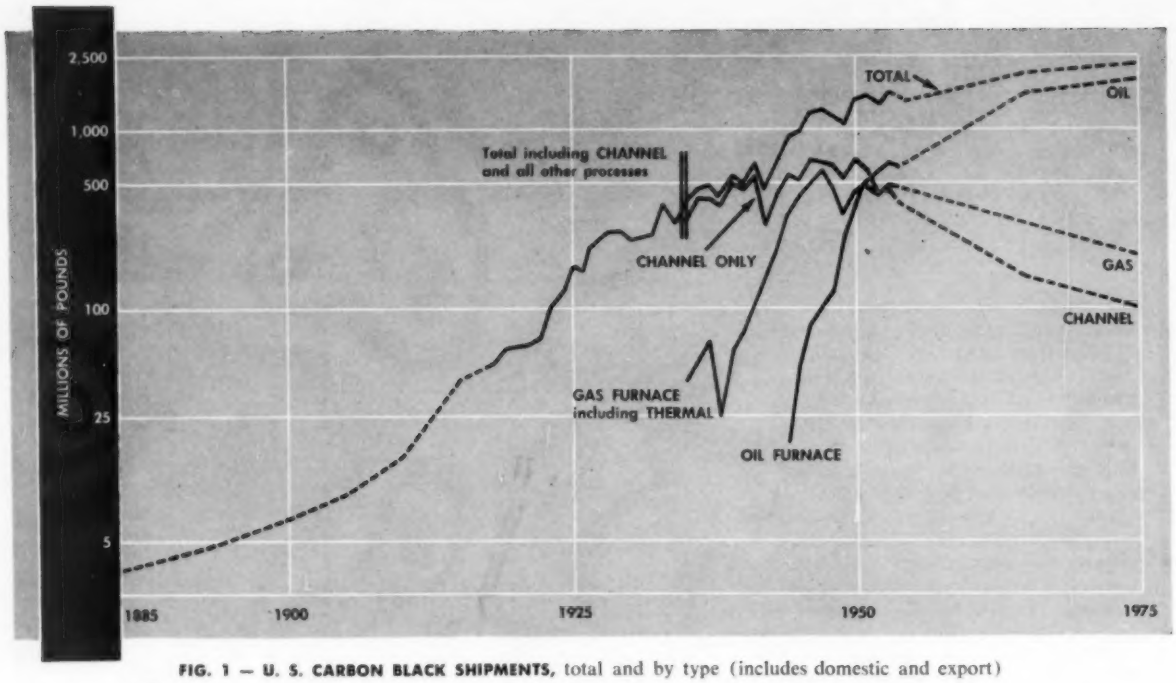


FIG. 1 — U. S. CARBON BLACK SHIPMENTS, total and by type (includes domestic and export)

PETROCHEMICALS — TOMORROW

The Outlook for... Carbon Black

By ALAN F. BEEDE and C. A. STOKES
Godfrey L. Cabot, Inc., Boston, Mass.

CARBON BLACK is a petrochemical of world-wide importance—an essential in modern industrialized society. According to the common definitions of a petrochemical, it must be considered the first petrochemical to have been produced in significant volume.

Technically, carbon black is a very finely divided carbon, the product of the controlled combustion of hydrocarbons. From a functional standpoint, the durability it imparts to tires provides the basis for the motor transport and the automobile manufacturing industries; and in sequence the steel industry, the oil industry, and many others find that their existence in some degree stems from the functions performed by carbon black. The communication of men's ideas through the printed page requires carbon black in the form of ink, and thus this commodity achieves enormous importance in literature, in the field of news, in education and in government.

Carbon black has no adequate substitute. Further, there is no strong economic need for one, since, as is the case with the petrochemical industry as a whole, the raw materials from which carbon black is made are fuels of petroleum or coal tar origin. Yields are high enough and raw material costs low enough to make it unlikely that any other synthetic pigment could compete cost-wise with carbon black. The petroleum and coal tar fuels now used will continue as feed stocks for the carbon black industry for many years just as these fuels are expected to continue as the basis for the petrochemical industry.[1] This article will attempt to present a picture of the present and the future of the carbon black industry, the raw material requirements, and an appraisal of the technological or economic changes that may be expected.

A Quick Summary

Expansion — The historical world domination of the carbon black industry by the United States is being challenged by construction of foreign oil furnace black plants. Future construction of new capacity to meet rising world demands will probably take place largely outside of this country.

Products—The former near-monopoly of gas channel black has been broken by furnace processes, and oil furnace blacks are almost certain to become the single preferred type except for small special requirements that can be filled only by the products of the older processes.

Developments—It seems likely that carbon black has entered a stable era as regards process and product development. New developments will probably be limited to minor process improvements and occasional new grades of blacks.

Raw Materials—Although fuel requirements of the industry are but a small fraction of total petroleum output, adequate, stable supplies of uniform quality are not easy to find. Coal tar fractions or oil from synthetic fuel plants can be used readily in the oil furnace process whenever changed economic factors dictate such shifts.

Problems—Looking ahead, the industry's most serious problems seem to be:

1. The need for a stable supply of low cost fuel of uniform quality.
2. The need for industry-wide standardization of the many grades.

Markets—Since the advent of GR-S no other new markets of great significance have been found for carbon blacks, but there is now no effective commercial substitute nor is it likely that one will appear to take over the

major markets. The recently publicized use of carbon black in polyethylene is simply an extension into an already established use in the plastics field.

Competition—The danger of serious reduction of demand for carbon black, because of the widespread displacement of rubber by non-carbon black using materials, appears to be small and not imminent. On the other hand, the growth of carbon black markets for rubber uses outside the tire field will be diminished by competition of other fillers, especially white fillers, and by development of new synthetic rubbers and rubber replacements that will require little or no carbon black. The future of carbon black continues to be tied to the motor transport industry and rubber manufacture.

Structure and History Of the Industry

The carbon black industry is highly concentrated, both as to production and as to markets. Over 90% of the world's carbon black is produced by eight companies in the U.S. The industry is not a large one according to the American scale; the value of a year's production at plant is about $100 million. On the market side, the rubber manufacturing industry, which takes about 93% of domestic shipments, is led by the large tire companies often referred to as the "Big 4" or "Big 5."

Most carbon black producers engage in other lines of business with strong emphasis on the production of natural gas and oil, and pigments for ink and other uses. Diversification, however, has not been as extensive as in some of the other industries, and carbon black manufacturers have not expanded their operations into the manufacture of some of the newer petrochemicals.

The carbon black industry is not integrated either vertically or horizontally and is independent—no company is a captive producer. Only a small portion of raw materials is produced by carbon black makers; the bulk is purchased. Only in a few instances does the carbon black producer consume black as a component in the manufacture of a finished product, e.g., ink for some companies and synthetic rubber at one company. The industry places strong reliance on intensive and competitive research and development work in an effort to keep pace with the extremely active and successful research and development work of the rubber companies.

The history of carbon black can be viewed in proper perspective if it is divided into three eras—the lampblack, the natural gas, and the present oil era.

The lampblack era extended through the eighteenth and nineteenth centuries, when coal tar fuels provided the raw material and production was very small compared to current rates. The product was used almost entirely as pigment for paints and inks.

The natural gas era began in the late nineteenth century with a process using the impingement of small flames on a cooled iron surface—essentially the same as the channel process employed in the U.S. today. Because of extremely low yields this channel process was dependent upon cheap natural gas and, therefore, the U.S. rapidly began to take over the world's markets for carbon black except for a small production of lampblack in Europe.

The real growth of the carbon black industry started about 1917, when tire makers first began to use high carbon black loadings in tire tread compounds. As a result of this development, the U.S., possessing both cheap natural gas and the transportation market for rubber products, became completely dominant in world carbon black production. A decline from this position began only when Germany, just before World War II, perfected a method of using liquid coal tar products as raw materials in a channel type process.

In the period 1920 to 1945—still the natural gas era—furnace and thermal black processes were developed around the availability of cheap natural gas. These blacks possessed lower rubber reinforcing power and less blackness in inks than channel blacks. Nevertheless, gas furnace blacks—somewhat cheaper because of high yields—found growing and important use. During the War, with the great increase in synthetic rubber consumption, gas furnace blacks were in great demand because they permitted high loadings with low heat generation and still maintained elasticity and rebound.

The oil furnace black era has placed on the market not only blacks made wholly from liquid hydrocarbons but several grades made by oil enrichment of natural gas. In many ways these new blacks, in all cases based

Meet the Authors

The two authors of this article on carbon black should be well qualified to discuss the subject, since between them they have had over two decades of experience in the technical and business phases of the petrochemical under discussion.

Mr. Beede

Alan F. Beede joined Godfrey L. Cabot, Inc., one of the leading carbon black producers, in 1943 as assistant to the treasurer, and since 1950 has served as a director. His present assignment with the firm covers internal corporate finance, budgetary control of capital expenditures, forecast of earnings and financial position, study of internal operating problems and return of capital investment, the economics of the carbon black industry, and the condition of the U. S. economy. He holds a B.B.A. from the University of Washington, and a M.B.A. from Harvard's Graduate School of Business Administration.

Dr. Stokes

C. A. Stokes became a consultant for the Cabot firm in the same year that Mr. Beede joined up—1943—and has been associated with the company or its subsidiaries ever since except for a few months in 1945 with the War Production Board. He has been a director of research and development since 1945, and also vice president and director of Petrocarb Equipment Co., a subsidiary, since 1951. He received his B.S. in chemical engineering from the University of Florida in 1938, and his Sc.D from M.I.T. in 1951 (his studies were completed in 1941, but thesis was delayed by war work).

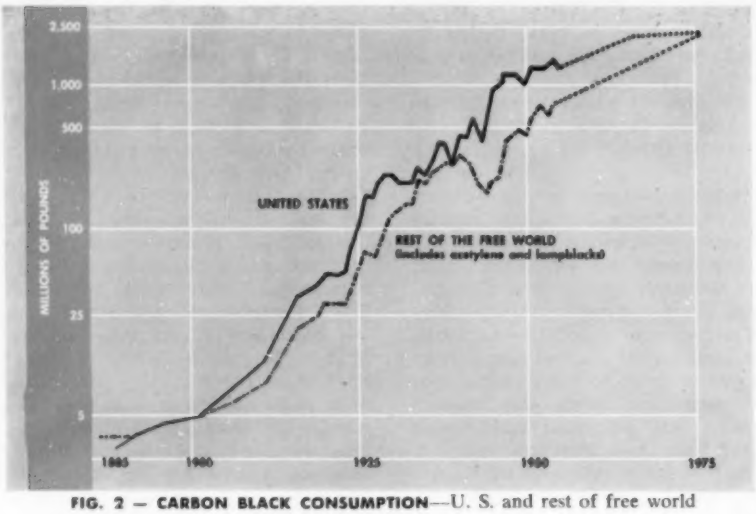


FIG. 2 — CARBON BLACK CONSUMPTION—U. S. and rest of free world

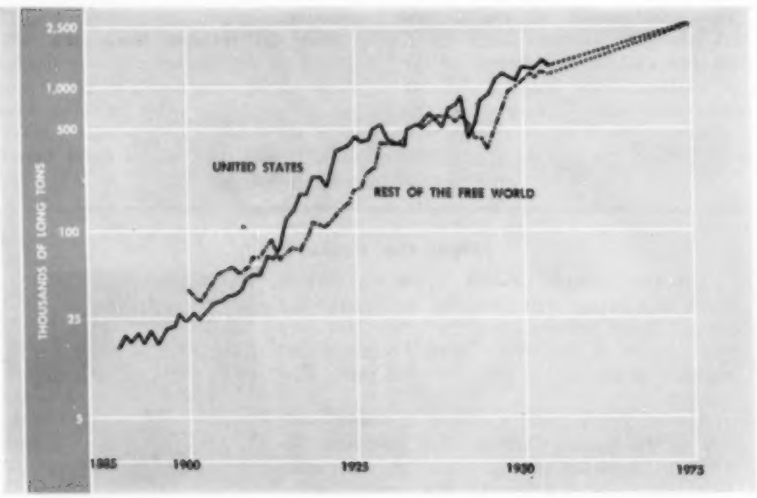


FIG. 3 — RUBBER CONSUMPTION—U. S. and rest of free world

upon petroleum oil, were better suited to synthetic rubber than any blacks previously available. Further, oil blacks have demonstrated many superior characteristics in natural rubber. This technical preference, together with the economic pressure of rising natural gas prices and the clearly demonstrated economy and flexibility of the oil furnace black process, resulted in the rapid growth of oil furnace black production.

A leveling off of total U.S. carbon black shipments has occurred since 1950, following the very rapid postwar upsurge, as shown in Fig. 1. U.S. channel black shipments have reached a peak and are declining, gas furnace black shipments have reached a plateau, and oil furnace black has experienced a rocketlike rise since introduction in 1944; 1953 oil furnace black shipments exceeded either channel or gas furnace totals.

As the dominant world supplier of carbon black, the U.S. has exported a large proportion (25%, 1947-1953 average) of total shipments. By long established custom, the foreign market has supplemented the high quality carbon blacks imported from this country with lampblacks and acetylene black. Historically, consumption of all blacks in the rest of the free world excluding the U.S. has paralleled closely, though at a substantially lower rate, the consumption of carbon black in the U.S. Although, as Fig. 2 shows, total non-U.S. consumption of blacks almost equalled U.S. consumption in the middle 1930's, the gap widened sharply just before World War II. From the recent low point in 1943, consumption of blacks in the rest of the free world rose 312% to 1953, while the gain in U.S. domestic consumption from the low in 1942 was 256%.

Like the domestic market, foreign demand for blacks is dominated by rubber consumption. It is important to the present and the future of the carbon black industry that rubber consumption of the free world excluding the U.S. has been rising at a very rapid rate in recent years. Fig. 3 presents the historical record of world rubber consumption; it is significant that the U.S. carbon black industry, as pictured in Fig. 1, apparently has passed its period of most rapid growth and may be reaching maturity. It is not clear (again referring to Fig. 3) either for the U.S. or the rest of the free world that rubber consumption is approaching maturity.

Carbon black capacity in the U.S. has been approximately tripled since 1939 not only to meet the increase in demand but also to satisfy government production goals. From the channel black portion of the natural gas era to the present first years of the oil era total U.S. carbon black capacity has risen from about 600 million lbs./yr. in 1939 to about 2 billion lbs./yr. in 1953. Channel black capacity at the beginning of the period amounted to about 600 million lbs. annually; by 1953 it had dropped to around 500 million lbs. Further rapid reduction is imminent because pipeline buyers of natural gas are bidding gas price above that which can be paid by channel black producers.

It is generally recognized in the industry that the last gas channel plant has been built; in fact, no new channel plants have been built with private capital since the early 1940's. It is not likely that additional gas furnace plants will be built. Future new capacity, whether in the U.S. or elsewhere, will probably use only oil or oil in combination with natural gas.

All of the carbon black industry's expansion in this country, excepting some World War II emergency construction of channel plants, has been privately financed.

In recent years the carbon black industry has experienced a twofold revolution of great significance. Its technical aspect has been the shift of raw material from gas to oil and from unconfined combustion to combustion in furnaces. The economic aspect, taking advantage of the lower transporta-

Table 1—Carbon Blacks Classified by Major Features of Manufacturing Processes and by Fuels Used

TYPE OF BLACK (and range of average particle size)[1]	MAJOR FEATURES OF PROCESSES	RAW MATERIALS: Make Fuel	RAW MATERIALS: Auxiliary Fuel	YIELD RANGE (as % of carbon in make fuel or in single fuel where no auxiliary fuel is used)	PRICE RANGE in U. S. and Canada ($/lb.)[7]	Order of Magnitude 1953 WORLD PRODUCTION outside U.S.S.R. and satellites (million lbs. per yr.)
Furnace (15-80 mμ)	Confined partial combustion under closely controlled high-turbulence conditions. Black once formed is not exposed to oxygen-containing atmosphere.	natural gas	none	10-30	.045-.065	1,200
		petroleum distillates	natural gas[3]	20-65	.05-.135[8]	
		petroleum residual oils	natural gas			
		coal tar distillates	coke oven gas[4]	30-60	n.a.	
Channel (10-35 mμ)	Impingement of unconfined partial combustion diffusion flame on air- or water-cooled metal surface. Black once formed is exposed to air at temperatures high enough for appreciable surface oxidation to occur in the length of time the black is so exposed.	natural gas	none	1-6	.074-.71[9]	520
		petroleum distillates	natural gas	10-50		
		coal tar distillates	coke oven gas	10-65	n.a.	
Thermal (150-500 mμ)	Regenerative cracking by heat transferred to gas or vapor from refractory surfaces. No oxygen present.	natural gas	hydrogen	25-40	.035-.055	100
		natural gas	natural gas[5]	20-30	n.a.	n.a.
		petroleum distillates or residual oils[6]	petroleum distillates or residual oils or oil gas	n.a.	n.a.	n.a.
Lamp (40-200 mμ)	Confined partial combustion under relatively uncontrolled low-turbulence conditions followed by admission of air at temperatures high and times long enough to allow surface oxidation of the black.	coal tar distillates	none	20-60	.11-.44	50-75
		petroleum distillates	none	n.a.	n.a.	neg.
		petroleum residual oils	none	n.a.	n.a.	neg.
Acetylene (35-50 mμ)	Confined *exothermic* cracking of acetylene at extremely high temperatures. No oxygen present.	acetylene	none	95+	.17	15-25
	Confined *endothermic* cracking of hydrocarbon gases or vapors in an electric arc.[2] No oxygen present.	natural or refinery gas or petroleum distillates	none	n.a.	n.a.	n.a.
	Confined *authothermic* cracking of hydrocarbon gases or vapors.[2] Black once formed is not exposed to oxygen-containing atmosphere.	natural or refinery gas (make and auxiliary fuel indistinguishable)		n.a.	n.a.	n.a.

Notes:

n.a. Data not available
neg. Negligible amount

(1) Arithmetic mean diameter of commercial products, as determined by electron microsopy, in millimicrons.

(2) In these processes the black is a by-product; acetylene is the primary product.

(3) Refinery gas may be used as auxiliary fuel in place of natural gas; in at least two foreign furnace plants refinery gas has been used as auxiliary fuel with petroleum or coal tar fuels or mixtures of the two as make fuels. In all cases in which natural gas is specified, propane and butane can be added to the natural gas or could, in most cases, be substituted for all of the natural gas.

(4) Plant under construction to use this combination.

(5) This combination is ordinarily used in processes in which hydrogen is the desired product and black is a by-product.

(6) This combination is used in making low Btu oil gas by the Jones and Pacific Coast processes; the black is a by-product.

(7) Carload prices, f.o.b. plant, in cheapest domestic package available. Prices are 0.25¢/lb. lower for furnace blacks, 0.4¢/lb. lower for channel blacks when these blacks are sold in bulk cars.

(8) This range covers practically all the oil blacks sold. Specialty grades sell up to 18¢/lb. but as yet such specialty grades are of negligible importance.

(9) This range covers practically all the channel blacks sold, with the greatest volume (about 80% of total) selling at 7.4¢/lb. Specialty high-color grades sell up to $1.60/lb.

tion cost of liquid raw materials as against gas or the finished product, is the new ability to locate plants close to markets instead of at those distant points where natural gas is produced.

The result has been the completion of three oil black plants: two in England in 1950 and 1951 and one in Canada in 1953. Dollar shortages and the obvious economy of transporting oil in tankers, as compared with shipping the low density, hard-to-handle carbon black packaged in bags and cases, have made inevitable this establishment of foreign plants. The increasing position of carbon black production beyond the borders of the U.S. may be expected to continue. A further step was the recent licensing of a long time carbon black manufacturer in Germany to produce blacks under German counterparts of U.S. patents and patent applications. Substantial new German production is therefore expected beginning sometime in 1955 using coal tar fuels as raw materials.

Types of Blacks And Raw Materials

In Table 1 carbon black processes are classified; the listing includes all processes used industrially throughout the world to produce carbon black as a primary product or in significant quantities as a by-product. In no case is a purely by-product black of much practical value for use in rubber or inks because the quality of such by-product black cannot be rigidly controlled. The blacks are listed in order of commercial importance, furnace black being the most important and acetylene the least. While channel blacks are still important, their use in the future will almost certainly diminish to the order of 100 million lbs./yr. for applications in which a combination of extreme blackness and certain properties in various dispersion media is required. Prices of the channel blacks will have to be increased significantly if they are to survive even on this limited basis. For such limited uses channel blacks will probably be made from natural gas enriched with vapors of aromatic oils.

A constant and vitally important problem of the carbon black industry today is finding adequate supplies of liquid hydrocarbons of the proper quality at prices close to those of heating fuel. From a quality standpoint almost any supply of natural gas can be used for channel black or for those grades of furnace black still made from gas. However, the supply problem is not so simple for oil based furnace blacks. While oils of the spe-

Table 2—Sources of Aromatic Hydrocarbons in High Concentration in Petroleum Refinery Streams

I. Uncracked or virgin oils
- A. Distillate
  - 1. Extracts obtained by refining with selective solvents
    - a. Lube extracts (the heavier lube extracts would be properly classified as residual for all practical purposes)
    - b. Kerosene extracts (may also arise from cracked stocks)
- B. Residual—none

II. Cracked oils
- A. Distillate
  - 1. Cycle stocks and/or product streams
    - a. Cycle stock from thermal cracking
    - b. Cycle stock from catalytic cracking (various side cuts and slurry oil)
    - c. Hydroformer bottoms
    - d. Cycle stock from vapor phase coking
    - e. Distillate fractions from high temperature steam diluted—gas oil cracking in petrochemical operations
  - 2. Extracts obtained by refining with selective solvents
    - a. Catalytic cycle stock extract
    - b. Kerosene extract from cracked kerosene fractions
- B. Residual
  - 1. Tars
    - a. Tar from thermal cracking of selected virgin gas oils
    - b. Tar from thermal cracking of catalytic cycle stocks
    - c. Tar from thermal cracking steam diluted of lube extracts
    - d. Tar from high temperature gas oil cracking to make olefins for petrochemical operations
    - e. Polyformer tar
    - f. Tar from thermal reforming of naphthas

cial quality required are frequently present in the product streams of the average refinery, they do not too readily appear in marketable quantity under adequate quality control. Certain adjustments to preserve the refiner's product balance and to maintain gasoline quality control are necessary. Solution of these problems can make available oil furnace black raw materials of required characteristics.

In addition to proper oil quality as such, *uniformity* of oil quality is almost equally important to the carbon black producer. A third requirement is low cost, since, as mentioned before, the carbon black price structure is based on oil fuels in the price range of residual and distillate heating oils. Finally the oil used must be available in sufficient quantity and for a long period to justify the large capital investment in a modern furnace black plant.

It is believed that carbon black is formed only by the condensation or aggregation of molecular fragments existing momentarily in the products of cracking vaporized hydrocarbons in a flame front. In other words, the raw material must always undergo vaporization. Carbon formed in the liquid phase of the hydrocarbon droplet is a cokelike material; in fact, hollow spheres or "coke balls" can be formed in this way. Thus we can say that in order for a hydrocarbon to be useable as a raw material for carbon black it must be substantially completely vaporizable in about 0.1 sec. under the conditions of the furnace and with the particular degree and type of atomization employed.

These conditions of the furnace may be described in general as partial pressure flash evaporation of finely atomized liquid by heat radiated back from a highly luminous flame mass at a temperature of about 2600± 100° F. Under these conditions a material of very high molecular weight (perhaps up to 500) can be expected to vaporize almost completely before appreciable cracking occurs in the liquid phase. Once the original liquid has evaporated, it seems likely that no liquid phase reappears; instead, carbon black nuclei must form as "solid" particles directly from the hydrocarbon vapor.

High molecular weight polynuclear aromatics can perhaps exist a fraction of a second in the vapor state at the high temperatures involved because of their high inherent structural stability; then, as they collide with other similar compounds or with solid carbon black lattice fragments which act as nuclei or with aggregates of such nuclei, they quickly dehydrogenate further and become attached, at least partly by primary valence bonding, to whatever type of particle is involved in the collision.

A straight chain paraffin, normal hexane for example, has to undergo dehydrogenation, cyclization, condensation and/or polymerization and, finally, collision with a carbon black nucleus or a growing particle before it is converted to carbon black. Its chances of passing through all these steps before it is oxygenated are much less than for the aromatic compounds.

On the other hand, aromatic compounds, such as benzene, can reach the carbon black nuclei stage more quickly and safely so that many more nuclei are formed in a given time interval; these nuclei grow rapidly but consume all the remaining hydrocarbon before many coarse carbon particles are formed. Thus aromatic compounds not only give a higher yield of carbon black but, other things being equal, give a more finely divided black. The aromatic hydrocarbon also gives a characteristic higher degree of agglomeration of particles (usually referred to as "structure"), partly because more nuclei are formed, and these are formed earlier and grow more rapidly. With a polynuclear aromatic fuel such as anthracene the results obtained with benzene are accentuated to a high degree, just as the opposite type of result which is characteristic of normal hexane is accentuated with methane.

Aromaticity is the single most important property of a suitable carbon black fuel. A desirable raw material is a mixture of di-, tri-, and poly-nuclear aromatics substantially free from asphaltenes and low in resins. This generalized specification not only defines the approximate lower molecular weight range but also pretty well indicates to the refiner where in his streams may be found desirable carbon black fuels. Table 2 lists and classifies the sources of such aromatics in refineries. The principal fuels used today are of three main types:

Cycle stocks from catalytic and thermal cracking.

Aromatic extracts from catalytic cycle stocks.

Tar from thermal cracking of catalytic cycle stocks.

Coal tar fuels are used commercially for furnace black only in England and Germany. The distillate cut between creosote and pitch, commonly called anthracene oil, is the fuel used in the largest quantity.

Oxygen and nitrogen in combined form in a fuel apparently have no effect on the properties of the resulting black in small amounts; at least the black produced contains no appreciable nitrogen or oxygen. Experiments have not been made, however, with fuels containing large amounts of combined oxygen and nitrogen.

Sulfur in combined form in a fuel may show up as free and combined sulfur in the black. No investigation has been reported of a systematic

study of the distribution of sulfur from the fuel to the black and flue gases. It is known from commercial experience that not more than a trace of the sulfur remains as sulfur dioxide or trioxide; instead, the sulfur in the flue gas is largely H_2S and perhaps partly in the form of COS. This result is in accordance with predictions based on thermodynamic data. Fuels containing up to about 2.5% sulfur have been used for several years to make certain types of furnace blacks known to the rubber industry as "fast extruding" (or "smooth-out" type) and "high abrasion" blacks. To impose a sulfur specification lower than about 1.5% on carbon black fuel would seriously limit the availability of suitable fuels.

Free carbon in a fuel, either in the form of suspended thermal carbon black or in the form of coke particles, cannot be tolerated above a few tenths of 1%. Only coal tar fuels are apt to contain thermal carbon black but both petroleum and coal tar fuels may contain coke particles ranging in size from a few microns up to 50 to 100 microns. The coke is more apt to cause difficulties in meters and control valves than to degrade the product seriously unless there are several tenths of a per cent present. Thermal black is present in all raw coal tars from high temperature ovens and possibly in the case of some tars from "low temperature" carbonization processes. This black is formed by thermal cracking in the vapor space above the coke or in the vapor-filled interstices of the coke bed. Such contamination will range from about 2 to 8% by weight of the crude coal tar and will be correspondingly greater in the residues from coal tar distillation. The particle size of this thermal black is of the order of 0.3-0.5 microns, whereas high quality reinforcing carbon blacks have a mean particle size of 0.025-0.03 microns.

Ash content of a fuel may affect:

1. Life of furnace refractories.
2. Total ash content of the product. (The total ash is the sum of ash from the fuel, from the cooling water and from miscellaneous sources of contamination such as refractory dust and iron oxide rust and scale. In the case of so-called distillate fuels, the ash content is negligible; likewise in the case of petroleum aromatic tars the ash content is usually negligible because the cracking stock is an overhead product. An exception to this occurs if the refiner adds lime to reduce corrosion of the cracking equipment by sulfur from the fuel; the carbon black producer must avoid fuels treated in this manner.)
3. Curing characteristics of rubber stocks containing the black.
4. Aging characteristics of rubber stocks containing the black (largely due to traces of certain metals).

To summarize: Almost any supply of natural gas can be used for channel black or for those grades of furnace black made from gas. The real problem of the present and the future is the obtaining of a stable supply of liquid hydrocarbons at low cost and uniform quality. Those fuel oils which are economic in carbon black manufacture are not readily obtainable from the average refinery.

Processing Technology

The technology of lampblack, channel black and gas furnace black is adequately described in the literature.[2-6] Oil furnace black technology has also been covered in recent articles;[7-9] however, since oil furnace black is of such great importance, a brief review of process technology is given here.

The modern furnace black process using liquid raw materials consists of more than merely burning oil with insufficient air for complete combustion. There are several distinct steps involved, each of which can present many complex problems which must be solved if a steady, efficient operation is to be maintained.

1. Feed preparation—this may include blending, preheating, filtering, desulfurizing (gaseous fuels), dehydration, precracking (gaseous fuels), vaporizing, compressing (gaseous fuels) or pressurizing (liquid fuels).
2. Combustion—this includes the critically important step of atomization, unless vaporized oil is used, together with exact control of turbulence and juxtaposition of make fuel, auxiliary fuel and air streams.
3. Cooling — this includes the quenching of the reaction and the final adjustment of temperature to protect the collection system.
4. Primary collection — collecting the bulk of the product.
5. Secondary collection—this step is the final clean-up necessary to prevent smoke or sludge nuisance.
6. Processing—densifying and pelletizing by dry or wet process, and drying in latter case, to save space and eliminate dust.
7. Product control.
8. Shipping—this involves a knowledge of best methods of handling bulk pelletized blacks at the plant in transit and at the customer's plant as well as all of the know-how involved in overland and export shipment in bags.

The heart of the process, as is the case with all carbon black processes, is the single step of partial combustion. This seemingly simple step has been the subject of most of the research in the carbon black industry in recent years.

The second most important step is that of pelletizing (Step 6), also the subject of much research and many patents. Oil blacks have proven to be more difficult to pelletize than channel or gas furnace blacks; wet pelletizing is apparently the best process from both a product quality and economic standpoint.

Secondary collection (Step 5) has been a serious problem until the last two or three years when bag filter collection and wet collection by scrubbers, with or without wet electrostatic precipitation in series, have been perfected. Sonic agglomeration, and collection, has been found effective but no commercially practical sonic agglomerating equipment is available at present.

The modern oil furnace process requires a plant of increasing complexity and capital cost, particularly as related to collection, processing and packaging methods. A corresponding upward trend of labor costs presents a growing problem to the carbon black manufacturer.

The accurate control of the carbon black production process in the furnace makes it possible to produce a much wider variety of grades for rubber now than was possible with the channel process, although the reverse is true with respect to the pigment grades. Significant progress from the earlier and relatively unsatisfactory synthetic rubbers, coupled with the highly competitive situation in the carbon black industry, has resulted in the development of what may prove to be an uneconomically large number of grades of furnace black.

There seems to be a clear need for the reduction of the number of grades. This might be accomplished by industry-wide standardization and the establishment of tolerances sufficiently wide to avoid the excessive cost of quality control caused by each producer having to match the others' "sub grades" of each generic grade.

In respect to this point the carbon black industry is faced with a problem similar to that faced by gasoline producers in the early years before API and ASTM groups introduced standard tests and specifications. Unfortunately, carbon black does not lend itself to accelerated end-use tests as does gasoline to a road octane test. In time, however, the use of scientifically designed road tests correlated with high

quality laboratory tests should enable the industry to establish satisfactory specifications.

As consumers narrow their choice of blacks from the many now offered the period of rapid change as regards both grades and process improvements will probably approach an end. For the future it seems likely that small process improvements and occasional new grades of black will be characteristic of the industry.

Future Outlook

The future of carbon black is here examined from two points of view: (1) markets and (2) substitutes or elimination. End-use of carbon black in the U.S. has recently been divided approximately 93% in manufactured rubber products and 7% combined for paints, ink and miscellaneous markets. The conclusion seems clear that rubber manufacturing will continue to be the principal buyer of carbon black throughout the world for many years to come. No important new markets are being developed. Some additional demand may appear in the plastics industry but the estimated total is very small in comparison with the demand by the rubber industry.

Geographically, the markets for carbon black fall into two categories: the U.S., and the rest of the free world. The latter offers a relatively more rapid growth than does the demand within this country. Again, the determining factor is rubber consumption.

According to the President's Materials Policy Commission[10] reporting in June 1952, total new rubber consumption in this country is expected to increase by about 87% from 1953 to 1975, while for the rest of the free world a gain of about 158% is forecast. The estimated increase of United States rubber consumption combines a modest 55% rise for transport rubber and close to a twofold gain for non-transport rubber, which requires less carbon black.

Substitutes for carbon black have long been sought unsuccessfully. So far, the unique surface chemistry of carbon black together with its low volume cost continues to insure that it is the preferred material for present uses. Further, there are no competitive substitutes which meet all the requirements of quantity, of price, of suitable raw material, and of installed or economically installable production facilities.

It has been suggested that use of carbon black might be eliminated by the substitution of non-carbon black using materials for rubber. New compounds (e.g. Vulcollan, Chemigum SL, Adiprene B) based on polyesters have recently been introduced with the claim that their durability in many uses is several times that of rubber. Apparently the polyester rubbers do not need to be reinforced by carbon black against abrasion as does rubber, but there are indications at least that carbon blacks or other fillers are needed when these rubbers are used for tires, the filler giving improved antiskid properties. However, it seems premature to assume that these materials will substantially displace rubber for automotive tires, especially in view of the high cost of the polyester materials even with large volume production.

Furthermore, as long as polyesters or other rubber substitutes cost more than rubber, there will be strong economic pressure to use some cost reducing additives and the most logical is carbon black. An important quality of carbon black is its ability to extend Vulcollan substantially without reducing its strength. Even if in years to come polyesters do supplant rubber in the U. S. to some extent, an important reduction in world demand for carbon black is by no means certain.

In the rest of the free world, the growth trend of carbon black appears relatively stronger than in the U. S. The near monopoly position of rubber seems unlikely to be broken by the rubber substitutes such as the polyester type because, first, many markets of the free world outside the Iron Curtain are close to natural rubber producing areas; second, as long as rubber sells at a lower price than polyesters, rubber will be the material of choice; and, third, even including the United Kingdom, Germany, and possibly France and South Africa, capital funds dedicated to the construction of rubber substitute plants will probably be too small to permit important displacement of rubber.

In brief, it seems clear that rubber consumption in the free world outside of the U. S. should rise more rapidly than in this country, that natural rubber will continue to be the preferred material, that carbon black will continue to be the preferred reinforcing agent, and that loading rates will rise as rubber compounding practices rise toward the higher rates now common in the U. S.

A projection of the future position of carbon black is presented in the series of charts used to illustrate this article. Fig. 1 suggests the possible approaching maturity of the carbon black industry in the U. S. A 1975 level of total shipments amounting to 2,250,000,000 lb. represents an increase over the 1953 level of about 44%. This is lower than the projected increase for the rest of the free world and reflects declining U. S. exports following increased foreign production and present estimates that rubber consumption in the U. S., and therefore carbon black consumption, will be limited by the motor vehicle population and the tires necessary to keep cars and trucks on the road.

Fig. 1 also projects a decline of both channel black and gas furnace black shipments to nominal levels and the assumption by oil blacks of all but about 13% of total U. S. shipments by 1975.

Total carbon black consumption in the U. S. is projected on Fig. 2 to increase by 83% by 1975, while the consumption of the rest of the world is forecast to show a 208% rise from 1953.

Rubber consumption in the U. S. and also in the rest of the free world, shown in Fig. 3, is projected at a rate higher than that considered reasonable for carbon black. Rubber consumption in the rest of the free world is projected to rise about 158% from the 1953 level, while the U. S. gain is estimated at 87%.

References

(1) Ayres, Eugene, "Raw Materials for Organic Chemicals," *Chem. Eng. News*, 32, 2876-82 (1954).

(2) Smith, W. R., Carbon Black, in "Encyclopedia of Chemical Technology —Vol. 3" pp. 34-65, edited by R. E. Kirk and D. F. Othmer, Interscience, New York (1949).

(3) Colvin, W. J., and Drown, W. E., Lampblack, *Ibid*, v. 3, pp. 80-84.

(4) Perry, C. H., et al., "Investigation into Manufacture and Use of Carbon Blacks and Lampblacks in Germany," BIOS Final Report 572, issued by U.S. Office of Technical Services as PB-46388 (1946).

(5) Thornhill, F. S., "Rubber Reinforcing Carbon Blacks from Naphthalene and Anthracene (CK3 and CK4 Blacks)," FIAT Final Report 1128, issued by U.S. Office of Technical Services as PB-88805 (1948).

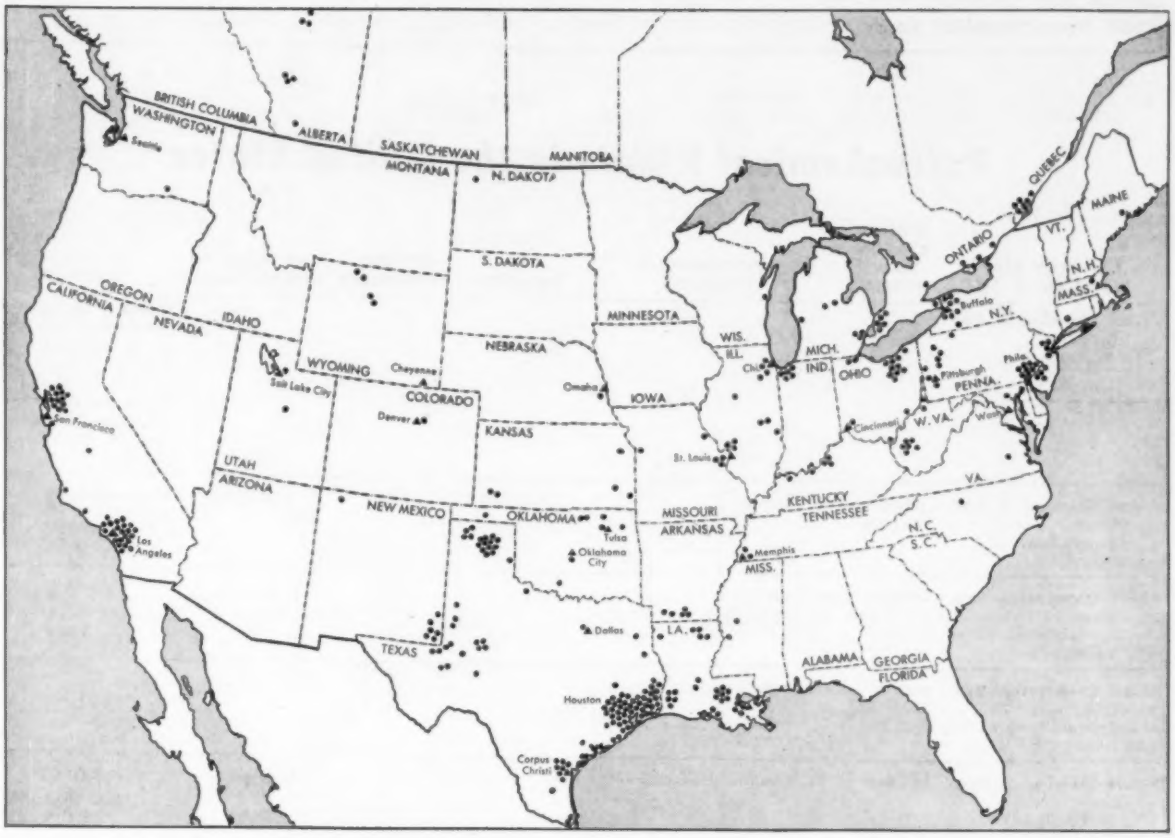
(6) Stokes, C. A., and Dobbin, R. E., "Carbon Black Shifts to Furnace Process," *Chem. Ind.*, 64, 40-43, 104 (Jan. 1949).

(7) Cabot, L. W., Edminster, J. W., and Stokes, C. A., "The Manufacture of Furnace Carbon Black from Liquid Hydrocarbons at Ellesmere Port," *J. Inst. Petroleum*, 36, 707-18 (Dec. 1950).

(8) Shearon, W. H., Reinke, R. A., and Ruble, T. A., "Oil Black," *Ind. Eng. Chem.*, 44, 685-694 (1952).

(9) "White Collar Blacks," *Chem. Eng. News*, 32, 2367 (June 14, 1954).

(10) U.S. President's Materials Policy Commission, "Resources for Freedom," by William S. Paley et al., vol. 2, pp. 99-102, 126, 135, Government Printing Office, Washington (1952).



TODAY'S PETROCHEMICAL INDUSTRY, as represented in this map of the U. S. and Canada. Each black dot represents one petrochemical plant. Note concentration at Gulf and Pacific Coasts

New 1954 Petrochemical Survey

Study shows 176 firms in petrochemicals, with 322 plants operating, building, or planned

A TOTAL of 41 new petrochemicals plants are currently in the planning or building stages in the United States and Canada, according to the latest survey of this industry conducted by the editors of PETROLEUM PROCESSING.

These new facilities represent an estimated investment of nearly $555,000,000. In addition, there are 34 expansion projects planned or underway at existing plants, representing about $175,000,000 more of new capital outlay.

Other facts shown in PETROLEUM PROCESSING's 1954 survey of the petrochemical industry:

- There are now 176 companies engaged in the manufacture of petrochemicals in the U. S. and Canada.

Of these, 62 are petroleum companies or petroleum company subsidiaries, 102 are chemical companies, and 12 are joint ventures between both kinds of firms or have undisclosed backgrounds.

- These companies now have a total of 322 plants in operation, under construction, or planned.
- During the past year, 44 new plants have been put into operation.

The new 1954 edition of the PETROLEUM PROCESSING annual survey of petrochemical plants appears on the following 23 pages. Since the last survey was published in May, 1953, 33 companies and 51 plants have been added to the list. These are "net" increases. There were 17 plants deleted from the previous list because of newer information regarding plans or because of changes in earlier plans.

In addition to the information given last year—company names and plant locations, hydrocarbon raw materials, petrochemical products, and plant managers—the 1954 survey includes (wherever the information was obtainable) approximate plant capacities and plant investments.

The selection of any individual plant for inclusion in the survey has been based—as it has in the past—upon the now commonly-accepted definition for a petrochemical. This definition was developed by the editors of PETROLEUM PROCESSING by means of a canvass of leading industry technologists (April, 1952, pp. 490-491). It is:

"Petrochemical, n: a chemical compound or element recovered from petroleum or natural gas or derived in whole or part from petroleum or natural gas hydrocarbons, and intended for chemical markets."

Petrochemical Plants in the United States

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Allied Chemical & Dye Corp. Baton Rouge, La.						Company received a certificate of necessity on an investment of $550,000 in April '53 for facilities at Baton Rouge, La., to produce "monomer for plastics used by the military services."
Allied Chemical & Dye Corp. (Barrett Div.) Frankford, Pa.	petroleum fractions	phenol	20,000,000 lb./yr.		C. J. Murphy, Mgr.	In operation since Feb. '54.
Allied Chemical & Dye Corp. (General Chemical Div.) El Segundo, Calif.	refinery gases (from Std. of Calif.)	sulfuric acid			J. V. Claes	
Allied Chemical & Dye Corp. (General Chemical Div.) Richmond, Calif.	refinery gases (from Std. of Calif.)	sulfuric acid			T. H. Compton	
Allied Chemical & Dye Corp. (Nat'l Aniline Div.) Buffalo, N. Y.	kerosine	synthetic detergents			C. C. Coakley, Mgr.	
Allied Chemical & Dye Corp. (Nitrogen Div.) La Platte, Neb.	natural gas	ammonia, urea	ammonia: 75,640 ton/yr. urea: 25,000 ton/yr.	$25,000,000	R. L. Riggs, Mgr.	Plans to double ammonia capacity were announced in Aug. '54. Completion date not set.
Allied Chemical & Dye Corp. (Nitrogen Div.) South Point, Ohio	natural gas	ammonia, methanol, urea	ammonia: 285,480 ton/yr.		C. W. Bahrt, Jr. Mgr.	Urea facilities are being expanded at a cost of about $5,000,000. Plans have also been reported for making urea fertilizer and urea cattle feed.
Allied Chemical & Dye Corp. (Nitrogen Div.) Orange, Texas	ethylene	ethylene oxide, ethylene glycol		$5,500,000	E. L. Ray, Mgr.	Facilities for production of ethanolamines are to be installed.
Allied Chemical & Dye Corp. (Nitrogen Div.) Hopewell, Va.	natural gas	ammonia	350,000 tons/yr.		F. A. Ernst, Mgr.	Facilities to increase ammonia capacity by 50,000 tons per year are being installed. Another project reported is a $12,000,000, DPA-certified, methanol and formaldehyde plant.
Allied Chemical & Dye Corp. (Semet-Solvay Div.) Buffalo, N. Y.	petroleum fractions	long chain polyethylene wax		$7,000,000	R. A. Lyon, Supt.	In operation since Dec. '53. Benzene recovered as a by-product.
Allied Chemical & Dye Corp. (Semet-Solvay Div.) Tonawanda, N. Y.	ethylene (from fuel oil)	polyethylenes	20,000,000 lb./yr.			In operation since early 1954.
Allied Chemical & Dye Corp. (Solvay Process Div.) Moundsville, W. Va.	natural gas	chlorinated methane products; methyl chloride, methylene chloride, chloroform, carbon tetrachloride		$2,000,000	R. C. Skinner, Mgr.	Plant was scheduled for completion in July, 1954.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Alox Corp. Niagara Falls, N. Y.	petroleum hydrocarbon (oil) fractions	rust preventive additives, oil additives, cutting oil	12,500,000 lb./yr.		A. A. O'Kelly, Tech. Dir.	
American Cyanamid Co. (Jefferson Parish) Avondale, La.	natural gas	ammonia, acetylene, hydrocyanic acid, acrylonitrile	ammonia: 109,000 ton/yr.	$47,745,000	G. J. Forney	Partly in operation, producing sulfuric acid and ammonium sulfate, since May '53; full completion was scheduled for summer '54. Company received DPA certificate in June, 1953, for $7,840,000 plant for monomethylstyrene. It also holds a $7,500,000 DPA certificate for a urea plant.
American Petro-Chemical Corp.						Joint venture of Cities Service Refining Corp. and Firestone Tire & Rubber Co., dissolved in 1954.
Ammonia Chemical Corp. of Calif. Oleander, Calif.	natural gas	ammonia	36,000 ton/yr.	$4,000,000		$4,000,000 DPA certificate announced June '54. Information given is on planned facilities, tentatively to be located south of Fresno, Calif.
Atlantic Refining Co. Philadelphia, Pa.	natural gas, petroleum fractions, refinery gases	ammonia, synthetic detergents, sulfuric acid	ammonia: 30,000 ton/yr.		D. T. Shaw, Mgr.	
Atlantic Refining Co. Atreco, Texas	petroleum fractions (benzene, propylene)	synthetic detergents			R. Stewart, Mgr.	
Atlas Powder Co. Wilmington, Del.		ammonia		$6,750,000		Plant location and actual raw material source not yet selected. Plant is still in early planning stages, although a certificate of necessity has been granted to cover the expected investment cost.
Atlas Processing Co. Shreveport, La.	petroleum naphtha	benzene			V. B. Chance, Pres.	
Bakelite Co. Marietta, Ohio		styrene		$2,722,000		Plant now under construction. Actual raw materials may include both petroleum and non-petroleum sources. This plant reported as Carbide & Carbon Chemicals in 1953.
Barium Reduction Corp. S. Charleston, W. Va.	natural gas	carbon disulfide, hydrogen sulfide			L. Preisman, Tech. Dir.	
Barnhart Hydrocarbon Corp. Big Lake, Texas	natural gas	channel carbon blacks			J. M. Sappington, Vice Pres.	Formerly operated as Witco Hydrocarbon Corp.; Witco Chemical Co. markets carbon black.
Brea Chemicals, Inc. Brea, Calif.	natural gas	dry ice and liquid CO_2	25,550 tons/yr.	$750,000	R. S. Ogilvie	Unit put into operation July, 1954. A subsidiary of Union Oil Co. of Calif.
Brea Chemicals, Inc. Brea, Calif.	natural gas	ammonia	85,775 tons/yr.	$13,000,000	R. S. Ogilvie	Unit put into operation May, 1954. A subsidiary of Union Oil Co. of Calif.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Brea Chemicals, Inc. Brea, Calif.	natural gas	nitric acid, ammonium nitrate, and ammonium phosphate		$2,500,000	R. S. Ogilvie	Final completion date of entire plant not yet set. A subsidiary of Union Oil Co. of Calif. Ammonium phosphate facilities set for completion this month. Two more units for this product under construction at Brawley and Fresno, Calif. Estimated cost is $500,000 for the units.
Bryton Chemical Co. Trainer, Pa.	petroleum fractions	oil-soluble sulfonates			E. W. Carlson	Now owned by Continental Oil Co.
Cabot Carbon Co. Franklin, La.	heavy oil, natural gas	oil, gas, and thermal blacks			H. S. Ayres	
Cabot Carbon Co. Ville Platte, La.	heavy oil, natural gas	oil & gas furnace blacks			R. T. Bowen	
Cabot Carbon Co. Hobbs, N. Mex.	natural gas	channel blacks			H. M. Coday	
Cabot Carbon Co. Guymon, Okla.		carbon black				Closed down since 1952.
Cabot Carbon Co. Dixon Plant Big Spring, Texas	petroleum residues	oil furnace blacks			A. R. Davenport	
Cabot Carbon Co. Kermit, Texas	natural gas	channel blacks			A. L. Dickson	
Cabot Carbon Co. Kingsmill, Texas		carbon black				Closed down since 1952.
Cabot Carbon Co. (General Atlas Div.) Pampa, Texas	natural gas, petroleum residues	oil and gas furnace blacks			E. J. O'Brient	
Cabot Carbon Co. Skellytown, Texas	natural gas	rubber channel blacks, special ink and paint blacks			W. L. Marshall (Shafer "A" Plant) J. M. Brown (Shafer "B" Plant)	
Cabot Carbon Co. Stinnett, Texas		carbon black				Closed down since 1948.
California Spray Chemicals Co. Richmond, Calif.	petroleum bases	n-trichloromethylthiotetrahydrophthalimide; n-butyl, 2,4-dichlorophenoxyacetate; isopropyl, 2,4-dichlorophenoxyacetate; isopropyl 2,4-dichlorophenoxy-acetic acid (diethanolamine, isopropanolamine and triethanolamine salts); tetrahydrofurfuryl 2,4,5-trichlorophenoxy acetate; tetraethyl pyrophosphate (TEPP); ethylene glycol mono-oleate.				
Carbide and Carbon Chemicals Co. Torrance, Calif.	refinery gases	polyethylene, ethylene glycol	polyethylene: 60,000,000 lb./yr. ethylene glycol: 10,000,000 gal./yr.	$36,323,000		Installation completion anticipated late 1954. Raw material obtained from adjacent refinery of General Petroleum Corp.
Carbide and Carbon Chemicals Co. Whiting, Ind.	refinery gases	synthetic organic chemicals, including ethylene glycol, isopropanol, acetic acid, acetic anhydride			W. J. Bagby	Division of Union Carbide and Carbon Co.
Carbide and Carbon Chemicals Co. Seadrift, Texas	natural gas	ethylene glycol, polyethylene		$66,000,000	C. M. Blair	Division of Union Carbide and Carbon Corp. Under construction. completion was scheduled for mid-'54.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Carbide and Carbon Chemicals Co. Texas City, Texas	natural and refinery gas	synthetic organic chemicals and resins including alcohols, glycols, ethylene-amines, acetone, acetic acid and acetic anhydride, vinyl resins, polyethylene, acetylene, hydrogen cyanide	polyethylene: 60,000,000 lb./yr.		E. J. Fox	Division of Union Carbide and Carbon Corp.
Carbide and Carbon Chemicals Co. Institute, W. Va.	natural gas	synthetic organic chemicals including ethanol, butanol, 2-ethylhexanol, glycols, acetic acid, acetic anhydride, maleic anhydride, styrene, polyethylene, plasticizers			C. H. Atwood	Division of Union Carbide and Carbon Corp.
Carbide and Carbon Chemicals Co. S. Charleston, W. Va.	natural and refinery gases	synthetic organic chemicals and resins, including: alcohols, glycols, ethers and oxides, esters, ketones, aldehydes, acetals, anhydrides, wetting agents, plasticizers, etc.; vinyl resins and polyethylene			K. H. Rowland, Genl. Supt.	
Carlisle Chemicals Works, Inc. Reading, Ohio	petroleum fractions	cutting and lube oil additives			W. R. Hawkins, Supt.	
Carthage Hydrocol, Inc. Brownsville, Texas	natural gas				L. L. Smith, Supt.	Plant presently being revamped. Stanolind Oil and Gas Co. has acquired the stock and notes of Carthage Hydrocol, Inc. Petrochemical products will be recovered in an adjoining chemical plant of Stanolind. (See also listing for Stanolind Oil and Gas Co.)
Celanese Corp. of America Bishop, Texas	propane, butane	synthetic organic chemicals including: methanol, n-propanol, formaldehyde, paraformaldehyde, acetaldehyde, acetic acid, acetone, butylene glycol, propylene oxide and glycol, dipropylene glycol, trioxane, iso-butanol, n-butanol, n-propyl acetate, iso-butyl acetate, solvents, methylal, n-butyl acetate			E. T. Lindsey	
Celanese Corp. of America Pampa, Texas	propane, butane	synthetic organic chemicals including: acetaldehyde, acetic acid, acetic anhydride, vinyl acetate, propionic acid, butyric acid, methanol and solvents	vinyl acetate: 30,000,000 lb./yr.		J. F. Frick	Vinyl acetate unit in operation since July '53.
Chillicothe Petrochemicals, Inc. Chillicothe, Texas	natural gas	anhydrous ammonia, urea	ammonia, 68,400 tons/yr.; urea, 54,000 tons/yr.	$14,000,000	R. A. Sitta, Pres.	Plant in planning stage. Company incorporated spring '54. Now receiving bids on various processes and routes to accomplish syntheses; financing yet to be arranged. Present organization replaces Chillicothe Chemical Mfg. Co, now dissolved, which planned a $17,000,000 chemicals-from-gas plant.
Cities Service Refining Corp. Lake Charles, La.	refinery gases	butadiene	60,000 tons/yr.		G. B. Wooster, Supt.	Government - owned plant operated by Cities Service.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Cities Service Oil Co. (Del.) Oklahoma City, Okla.	natural gas	methanol, acetaldehyde, formaldehyde, acetone				Crude mixtures only, shipped to Tallant plant for purification.
Cities Service Oil Co. (Del.) Tallant, Okla.	butane	methanol, acetaldehyde, formaldehyde, acetone			L. D. Botts, Chem. Supt.	
Columbia River Chemicals, Inc. Pasco, Wash.	Bunker C fuel oil	anhydrous ammonia, urea, ammonium sulfate	ammonia, 57,600 tons/yr.; urea, 39, 600 tons/yr.; ammonium sulfate, 50,400 tons/yr.	$12,000,000		Operation will be on fuel oil until natural gas becomes available in Washington state. Design and construction by Fluor Corp. Completion date not set.
Columbia-Southern Chemical Corp. Barberton, Ohio	ethylene	perchlorethylene			W. S. Straub	Subsidiary of Pittsburgh Plate Glass Co.
Columbia-Southern Chemical Corp. Natrium, W. Va.	petroleum fractions	chlorinated benzenes			C. E. Wolf	Construction of a $3,000,000, 33,000 ton/yr., ammonia plant under way; completion expected by April '55. Hydrogen, as raw material, to come from Natrium chemical plant.
Columbian Carbon Co. El Dorado, Ark.	natural gas and/ or petroleum fractions	furnace carbon black	70,000,000 lb./yr.		K. Barnes, Supervisor	
Columbian Carbon Co. Hickok, Kans.	natural gas and/ or petroleum fractions	furnace blacks			J. W. Buchanan, Supt.	
Columbian Carbon Co. Eola, La.	natural gas and/ or petroleum fractions	furnace blacks			R. H. Cobb	
Columbian Carbon Co. Eunice, N. Mex.	natural gas and casinghead gas	furnace and channel blacks	24,000,000 lbs./yr.	$2,000,000	C. E. Thompson, Supt.	
Columbian Carbon Co. Conroe, Texas	natural gas and/ or petroleum fractions	furnace blacks			C. C. May, Supt.	
Columbian Carbon Co. Corpus Christi, Texas	natural gas and/ or petroleum fractions	furnace and channel blacks			J. C. Aulds, Supt.	
Columbian Carbon Co. Fortune, Texas	natural gas and/ or petroleum fractions	furnace carbon black	14,000,000 lb./yr.		J. S. Norris, Jr. Supervisor	
Columbian Carbon Co. Kingsmill, Texas	natural gas	channel black	7,200,000 lb./yr.	$460,000	R. M. Harvey Supt.	
Columbian Carbon Co. Lefors, Texas	natural gas and/ or petroleum fractions	channel blacks	26,000,000 lb./yr.		N. C. Jordan Supervisor	
Columbian Carbon Co. Seagraves, Texas	natural gas and/ or petroleum fractions	furnace blacks	45,900,000 lb./yr.		R. Fowler, Supervisor	
Columbian Carbon Co. Seminole, Texas	natural gas and/ or petroleum fractions	channel blacks	27,000,000 lb./yr.		J. E. Earhart, Supervisor	
Columbian Carbon Co. Sunray, Texas	natural gas and/ or petroleum fractions	channel blacks	25,500,000 lb./yr.		O. H. Johnston, Supervisor	

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Commercial Solvents Corp. Peoria, Ill.	natural gas (propane)	nitroparaffins			T. M. Walton	
Commercial Solvents Corp. Sterlington, La.	natural gas, ethylene glycol	ammonia, methanol, ammonium nitrate solutions, solid ammonium nitrate fertilizer	ammonia: 135,000 ton/yr.	$40,000,000	J. E. Wheeler, Gen. Mgr., Prod. Petrochemicals Div.	Nitro-paraffin plant using propane as raw material expected to be completed by July, 1955.
Consolidated Carbon Corp. of Illinois somewhere in Texas	natural gas	carbon black		$400,000		New company, using Lynn Furmatic process, has completed preliminary design and engineering for first of 10 proposed new plants. Plant will process 2,500 Mcfd of gas.
Consolidated Chemical Industries, Inc. Baton Rouge, La.	acid sludges	sulfuric acid			W. J. Daspit	Utilizes acid sludges from area refineries.
Consolidated Chemical Industries, Inc. Baytown, Texas	refinery gas and acid sludge	sulfur, sulfuric acid	sulfur: 17,500 ton/yr.		Z. L. Evans	Sulfur recovery unit completed Sept. '53; utilizes gases and sludge from adjacent refinery of Humble Oil & Refining Co. Sulfuric acid plant now under construction; completion scheduled for early '55
Consolidated Chemical Industries, Inc. Houston, Texas	acid sludge	sulfur			H. C. Snowden, Supt.	Plant under construction; completion scheduled for second quarter, '55. Will regenerate sulfur from acid sludge received from area refineries.
Continental Blacks, Inc. Ponca City, Okla.	refractory refinery cycle stock	oil furnace blacks	40,000,000 lb./yr.	$2,750,000	T. A. Ruble	In operation since May '54. Owned by Continental Oil Co. and Continental Carbon Co.; plants operated by the latter.
Continental Carbon Co. Eunice, N. Mex.	dry natural gas (LPG and natural gasoline removed)	channel black			R. A. Dosagr	
Continental Carbon Co. Sunray, Texas	dry natural gas, refractory refinery cycle stock	carbon blacks (including fast extruding furnace type, and semi-reinforcing)			O. Middlebrooks	
Continental Oil Co. Chicago, Ill.	dodecyl-benzene	water soluble sulfonates			P. E. Geiser	Formerly Stepan Chemical Co.
Continental Oil Co. Baltimore, Md.	benzene, propylene tetramer	synthetic detergent base stock			W. O. Miller	
Continental Oil Co. Lake Charles, La.	petroleum fractions	benzene, toluene, dodecene		$29,000,000	J. M. Jones	All units in operation since Oct. '53. Dodecene and benzene is delivered to the Continental petrochemical plant at Baltimore, Md., where dodecyl-benzene is produced for the detergent industry.
Continental Oil Co. Ponca City, Okla.	Petroleum fractions	benzene and other aromatic mixtures			C. D. Hull, Mgr.	New platformer of 3850 b/d capacity completed in April '54.
Continental Oil Black Co. Westlake, La.	refractory cycle stock	HAF carbon black			V. W. Fergus, Supt.	

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Cooperative Farm Chemicals Assn. Lawrence, Kans.	natural gas	anhydrous ammonia, ammonium nitrate	all products: 110,000 ton/yr. ammonia: 63,440 ton/yr.	$16,000,000	J. M. Wadsworth, Supt.	Under construction. Completion scheduled for Aug. '54. Company is an affiliate of Consumers Cooperative Assn., Kansas City, Mo.
Copolymer Corp. Baton Rouge, La.	butylene, styrene	butadiene, GR-S synthetic rubber	rubber: 49,000 ton/yr. butadiene: 23,000 ton/yr.		C. M. Hulings, Mgr.	Government-owned plant, operated by Copolymer Corp.
Cosden Petroleum Corp. Big Spring, Texas	mercaptans from extraction, aromatics from Platformer (Udex), olefines	alkyl mercaptans, benzene, toluene, xylene, polyisobutylenes, para-xylene		$3,000,000	W. K. Jackson, Dir., Organic Chem. Div.	
Cosden Petroleum Corp. Big Spring, Texas	petroleum fractions	nitration grade benzene, toluene, xylene			George Grimes, Supt.	
Deere & Company (Grand River Chemical Div.) Pryor, Okla.	natural gas	anhydrous ammonia and urea, industrial and fertilizer grades	ammonia, 65,880 ton/yr urea; 100,650 ton/yr.	$18,000,000	W. W. Yeandle, Wks. Mgr.	Anhydrous ammonia unit scheduled for completion July '54; urea unit scheduled for completion Sept. '54.
Delta Gas Chemical Corp. Buras, La.	natural gas	nitrogenous fertilizers				Certificate of necessity for $8,892,000 issued in March '52, has expired. John Pottharst, a New Orleans, La., electric utilities man, had original certificate and is reportedly still interested in the project.
Diamond Alkali Co. (Chlorinated Prods. Div.) Deer Park, Houston, Texas	ethylene	vinyl chloride, ethylene dichloride, perchlorethylene, paraffin solvent			H. S. Weiner, Mgr.	
Diamond Alkali Co. (Chlorinated Prods. Div.) Greens Bayou, Houston, Texas	benzene	benzene hexachloride, lindane trichlorobenzene			H. S. Curtis, Mgr.	
Diamond Alkali Co. (Chlorinated Prods. Div.) Belle, W. Va.	natural gas	methyl chloride, methylene chloride, chloroform, carbon tetrachloride			R. L. Muehlman, Mgr.	
Diamond Alkali Co. (Chlorinated Prods. Div.) Newark, N. J.	benzene	polychlorophenols, hexachlorobenzene, 2,4-D, 2,4,5-T			John Burton, Mgr.	
Diamond Alkali Co. (Chlorinated Prods. Div.) Painesville, Ohio	paraffin wax	chlorinated paraffin, liquid and resinous			R. C. Rahn Mgr.	
Dow Chemical Co. Gardena, Calif.	propane, benzene	styrene (toluene as a by-product)	57,000 ton/yr.	$15,000,000	L. G. Kline	Plant is owned by government, operated by Dow.
Dow Chemical Co. Midland, Mich.	ethylene, propylene (crude oil, natural gas)	styrene, butadiene, alpha methyl styrene, ethylene glycol, ethylbenzene, ethyl chloride, ethylene dibromide, diethyl benzene, divinyl benzene, ethylene dichloride, dichloroethyl ether, ethylene oxide, mono-, di-, tri-ethanolamine, ethylene diamine, isopropyl benzene, isopropyl chloride, propylene dichloride, propylene glycol, propylene oxide, isopropanolamines, polyglycols, polyglycol ethers, polyvinylidene chloride, ethyl cellulose, methyl cellulose, polyvinyl chloride			M. E. Putnam, Gen'l Mgr.&V.P.	

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Dow Chemical Co. Pittsburg, Calif.	natural gas	methylene chloride, methyl chloride, chloroform, carbon tetrachloride, perchloroethylene			H. H. Smith, Prod. Mgr.	
Dow Chemical Co. Torrance, Calif.	styrene	polystyrene			L. G. Kline, Supt.	
Dow Chemical Co. (Texas Division) Freeport and Velasco, Texas	butadiene, methane (natural gas), ethylene and propylene (cracking of ethane-propane mixtures), benzene	styrene, methyl chloride, ethyl chloride, ethylene dichloride, vinyl chloride, carbon tetrachloride, chloroform, ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, propylene glycol, perchlorethylene, trichlorethylene, dichlorethyl ether, dichlorisopropyl ether, ethylene oxide, propylene oxide, latex, methyl chloroform, methylene chloride, polyglycol, propylene dichloride, styrene oxide, toluene, vinylidene chloride			A. P. Beutel, Genl. Mgr.	Glycerol and polyethylene plans under construction. Cost estimated at $20,000,000.
du Pont, E. I. de Nemours & Co. Memphis, Tenn.	natural gas	hydrogen cyanide			T. D. Bell Mgr.	
du Pont, E. I. de Nemours & Co. La Porte, Texas	benzene	benzene hexachloride				This plant has not been operated in 1954
du Pont, E. I. de Nemours & Co. Orange, Texas	natural gas, propane, ethylene, benzene, cyclohexane	nylon intermediates (adipic acid, hexamethylene diamine), methanol, polyethylene	polyethylene: 100,000,000 lb/yr.		D. B. Campbell, Mgr.	
du Pont, E. I. de Nemours & Co. Victoria, Texas	natural gas, butadiene	adiponitrile			M. T. Shattuck	
Eastern States Chemical Corp. Houston, Texas	petroleum fractions	benzene and espesol aromatic and aliphatic solvents			L. G. Dufilho, Mgr.	Subsidiary of Eastern States Petroleum Co.
Equitable Gas Co. (undisclosed)	natural gas					Equitable Gas Co., Pittsburgh, Pa., has been reported to be considering the building of a plant at or near Ashland, Ky., on a gas pipeline, for the manufacture of such products as alcohol, ethylene oxide, glycol, polyethylene, ammonia and urea.
Esso Standard Oil Co. Baton Rouge, La.	refinery and natural gases, petroleum fractions	isopropyl alcohol, ethyl alcohol, iso-octyl alcohol, decyl alcohol, tridecyl alcohol, ethyl ether, isopropyl ether, isobutylene, butadiene, isoprene, tetrapropylene, tripropylene, benzene, dicyclopentadiene, petroleum resin, butyl rubber	butyl rubber, 47,000 ton/yr.		H. J. Voorhies, Gen. Mgr.	Butyl rubber plants are government-owned but operated by Esso.
Esso Standard Oil Co. Linden, N. J.	refinery gases and liquid fractions	isopropyl alcohol, acetone, secondary butyl alcohol, secondary butyl acetate, methyl ethyl ketone, isobutylene, polyisobutylene, lube oil additives, sulfuric acid			D. L. Hussey, Mgr.	

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Ethyl Corp. Baton Rouge, La.	ethane, ethylene, propane, benzene	ethyl chloride, ethylene dibromide, tetraethyl lead, benzene hexachloride, lindane			R. N. Clothier	
Ethyl Corp. Houston, Texas	ethylene	ethyl chloride, ethylene dichloride, antiknock compound			G. O. Hayes, Mgr.	
Ethyl-Dow Corp. Freeport, Texas	ethylene	ethylene dibromide			V. A. Thorpe	Subsidiary of Ethyl Corp. and Dow Chemical Co.
Firestone Plastics Co. Pottstown, Penna.	petroleum base stocks	polybutadiene-acrylonitrile type acyclic elastomers; and polybutadiene-styrene type acyclic elastomers			W. D. Handley, Mgr.	
Firestone Tire & Rubber Co. (Synthetic Rubber Div.) Lake Charles, La.	butadiene, styrene	GR-S synthetic rubber	100,000 long ton/yr.		W. H. Cain, Mgr.	Government-owned plant, operated by Firestone.
Firestone Tire & Rubber Co. (Synthetic Rubber Div.) Akron, Ohio	butadiene, styrene	GR-S synthetic rubber and latices	30,000 long ton/yr.		C. A. Hill, Div. Mgr.	Government-owned plant operated by Firestone.
Foster Grant Co., Inc. Baton Rouge, La.	ethylene, benzene	styrene monomer	4,000,000 lb./yr.	$4,000,000	F. D. Mayfield	In operation since Apr. '54. Ethylene from Esso Std. Oil Co.; benzene from open market.
Freeport Sulphur Co. Westville, N. J.	refinery gases	sulfur			E. F. Fay	Uses gases from The Texas Co. refinery at Westville.
General Petroleum Corp. Torrance, Calif.	refinery wastes	ammonium sulfate			A. E. Thompson, Mgr.	
General Tire & Rubber Co. Mogadore, Ohio	styrene and butadiene	polybutadiene, styrene, vinylpyridine type acyclic elastomers, rubber-base paint (latex)			J. A. Kleinhans, Mgr.	
General Tire & Rubber Co. Baytown, Texas	butadiene, styrene	GR-S synthetic rubber	44,000 ton/yr.		T. Lyman, Gen. Mgr.	Government-owned plant, operated by General.
Glidden Co. Cleveland, Ohio						Glidden has been licensed by Standard Oil Development Co. to conduct research on surface coatings from Standard's "C-Oil," a material derived from butadiene.
Globe Oil & Refining Co. Lemont, Ill.	refinery gases	sulfur	5,250 ton/yr.	$300,000	J. M. Lawson	In operation since Apr. '53. Company is now owned by Pure Oil Co.
Goodrich, B. F. Chemical Co. Louisville, Ky.	butadiene, styrene, acrylonitrile	nitrile type synthetic rubber			J. L. Nelson	
Goodrich, B. F. Chemical Co. Akron, Ohio	butadiene, styrene, acrylonitrile	nitrile type synthetic rubbers			F. C. Hands	
Goodrich, B. F. Chemical Co. Port Neches, Texas	butadiene, styrene	GR-S synthetic rubber	90,000 ton/yr.		W. R. Bateman, Mgr.	Government-owned plant, operated by Goodrich.
Goodrich, B. F. Chemical Co. Institute, W. Va.	butadiene, styrene	GR-S synthetic rubber	122,000 ton/yr.		J. R. Haas, Mgr.	Government-owned plant in standby.

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Goodrich-Gulf Chemicals Inc. Orange, Texas						Joint operation, in planning stage, of Gulf Oil Corp. and B. F. Goodrich Co. Site only at Orange; operations office in Pittsburgh, Pa.
Goodyear Synthetic Rubber Corp. Akron, Ohio	butadiene, styrene	GR-S synthetic rubber	15,200 ton/yr.		R. C. Stell	Government-owned plant, operated by Goodyear.
Goodyear Synthetic Rubber Corp. Houston, Texas	butadiene, styrene	GR-S synthetic rubber	99,600 ton/yr.		B. A. Rosinski	Government-owned plant, operated by Goodyear.
Goodyear Tire & Rubber Co. Akron, Ohio		high styrene resins, nitrile type synthetic rubber		$1,762,000 for styrene facilities	R. C. Stell, Mgr.	In operation since Sept. '53.
Grace Chemical Co. Woodstock, Tenn.	natural gas	anhydrous ammonia, urea	ammonia, 87,500 ton/yr.; urea, 52,500 ton/yr.	$20,000,000	J. G. Carriere	Subsidiary of W. R. Grace & Co. Under construction, completion scheduled for late '54.
Great Southern Chemical Corp. Corpus Christi, Texas	distillate gasoline	benzene, toluene, xylenes			L. K. Grove, Gen. Supt.	Company owned by Chicago Corp., Gulf Oil Corp., LaGloria Corp. and Pontiac Refining Corp. Plant in operation since Nov. '53. Wartime unit charging butane was shut down Apr. '54. Unit owned by government; disposition uncertain until government acts.
Griffin Chemical Co. Richmond, Calif.	crude petroleum sulfonates, naphthenates	naphthenic acid, lube oil additives			W. P. Ruedrich	
Gulf Oil Corp. Philadelphia, Pa.	refinery gases	propylene, sulfur			J. O. Timms, Gen. Supt.	Sulfur recovery unit in planning stage: $1,130,000 DPA certificate 10/29/52.
Gulf Oil Corp. Port Arthur, Texas	refinery gases, heptene	ethylene, sulfur, isooctyl alcohol	sulfur: 21,350 ton/yr. alcohols: 9,000,000 lb./yr. ethylene: 180,000,000 lb./yr.		R. C. Faulkner	Contract awarded and construction begun on second ethylene unit. Capacity has been reported as 3 billion cu. ft./yr.
Gulf Oil Corp. Waddell plant Crane County, Texas	natural gas	sulfur	7,000 ton/yr.		T. W. Rhoads	
Hancock Chemical Co. Long Beach, Calif.	refinery gases	sulfur			H. J. Gribben	Uses gases from refineries of Hancock, Richfield, Texaco and General Petroleum.
Hercules Powder Co. Hercules, Calif.	natural gas	anhydrous ammonia	50,000 tons/yr.		E. St. P. Bellinger	
Hercules Powder Co. Louisiana, Mo.	natural gas	anhydrous ammonia	42,000 ton/yr.	$5,000,000	J. B. Talley Mgr.	Formerly government-owned Missouri Ordnance Works (built by Hercules in 1942 for U. S. Army Ordnance Dept.) has now been leased, with option to buy, from the government by Hercules. Production of other chemicals—methanol, formaldehyde, and pentaerythritol, now being strongly considered.

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Hercules Powder Co. Burlington, N. J.		paraxylene	dimethyl terephthalate: 12,000,000 lbs./yr.	$4,500,000	D. A. Bunce	Under construction; completion scheduled for first quarter, '55.
Hercules Powder Co. Gibbstown, N. J.	cumene from benzene and propylene	phenol, acetone, p-cresol, cymene alcohol, flotation reagents	phenol, 26,000,000 lb./yr.; acetone, 16,000,000 lb./yr.		L. W. Rothenberger	Under construction; completion scheduled for Oct. '54.
Heresite Chemical Co. Manitowoc, Wis.	butadiene, styrene	polybutadiene-acrylonitrile type acyclic elastomers			I. L. Place	
Heyden Chemical Corp. Texas City, Texas						See listing of joint Monsanto-Heyden plant under Monsanto Chemical Co.
Hooker Electrochemical Co. Niagara Falls, N. Y.	benzene, toluene, pentane, wax	various chlorbenzenes, chlortoluenes and their derivatives, hexachlorocyclopentadiene and chlorinated waxes			H. B. Young, Wks. Mgr.	
Huber, J. M. Corp. Baytown, Texas	refractory cycle stock	furnace blacks			M. D. Nuttall	
Huber, J. M. Corp. Borger, Texas	natural gas	channel blacks, furnace blacks			J. L. Spear, Channel plant L. V. Mocsum, Furnace plant	
Huber, J. M. Corp. Eldon Texas	oil	carbon black			M. D. Nuttall	
Humble Oil & Refining Co. Baytown, Texas	refinery gases and petroleum fractions	butadiene, cyclohexane, toluene, xylene, aromatic solvents, aliphatic solvents, paraxylene, butyl rubber	butyl rubber: 43,000 ton/yr. butadiene: 49,000 ton/yr.		G. L. Farned, Mgr.	Butadiene and butyl rubber plants are government-owned, but operated by Humble. Paraxylene plant began operation Apr. '53.
Hyman, Julius & Co. Denver, Colo.	petroleum fractions	aldrin, dieldrin, specialty chemicals			J. G. Bejarano, Mgr.	Wholly-owned subsidiary of Shell Chemical Co.
Imperial Sulphur & Acid Co. Framington, N. Mex.	natural gas	sulfur	12,600 ton/yr.	$350,000	D. E. Cornell	
Jefferson Chemical Co. Port Neches, Texas	refinery gases	ethylene glycol, diethylene glycol, ethylene oxide, ethylene dichloride, mono-, di-, and tri-ethanolamine, nonyl phenol, aromatic distillate, morpholine, glycol ethers			L. R. Strawn	Owned jointly by American Cyanamid Co. and The Texas Co.
Jefferson Lake Sulphur Co. Manderson, Wyo.	acid gas	sulfur	43,200 ton/yr.	$700,000	G. F. Wilkins	Under construction; completion scheduled for late fall '54.
Kendall Refining Co. Bradford, Pa.					H. V. Smith, Mgr.	Company has 1500 b/d UOP Platformer but reformate is not now going into petrochemical production.
Kentucky Synthetic Rubber Corp. Louisville, Ky.	butadiene, styrene	GR-S synthetic rubber	44,000 ton/yr.		H. W. Cable, Mgr.	Government-owned plant, operated by Kentucky Synthetic Rubber Corp.
Koppers Co., Inc. (Kobuta plant) Monaca, Pa.	benzene and ethylene	styrene monomer, polystyrene, divinylbenzene	styrene, 50,000 tons/yr.; polystyrene, 25,000 tons/yr.		F. R. Garner	
Koppers Co., Inc. (Chemical Div.) Oil City, Pa.	petroleum fractions	alkylated cresols	2,400,000 lbs./yr.		C. L. Mehring	

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Koppers Co., Inc. (Chemical Div.) Williams Plant Port Arthur, Texas	ethylene	ethylbenzene			H. E. Roche, Mgr.	Polyethylene plant under construction; completion scheduled for mid '55.
Lion Oil Co. El Dorado, Ark.	natural gas	sulfur, ammonia, ammonium sulfate, ammonium nitrate	ammonia: 207,400 ton/yr.		A. M. Sprague	
Lion Oil Co. Barton Plant (St. Charles Parish) Luling, La.	natural gas	anhydrous ammonia, ammonium nitrate, dry ice, liquid carbon dioxide	ammonia, 108,000 tons/yr.; ammonium nitrate, 198,000 tons/yr., liquid and solid CO_2, 15,120 tons/yr.	$31,000,000	R. L. Van Zandt	Plant completed May '54.
Lubrizol Corp. Cleveland, Ohio	petroleum fractions	lube oil additives			F. V. Vencl, Prod. Mgr.	
Lubrizol Corp. Houston, Texas	petroleum fractions	lube oil additives			K. A. Danskin, Mgr.	
Magnolia Petroleum Co. Beaumont, Texas	petroleum fractions	organic solvents			J. W. Newton, V.P. and Mgr.	
Marbon Corp. Gary, Ind.	styrene, butadiene	high styrene resins			R. Shattuck, Mgr.	
Mathieson Chemical Corp. Magnolia, Ark.	natural gas	sulfur			J. C. Betteken, Op. Mgr.	
Mathieson Chemical Corp. McKamie, Ark.	natural gas	sulfur			J. C. Betteken, Op. Mgr.	
Mathieson Chemical Corp. Brandenburg, Ky.	ethane (natural gas)	ethylene oxide, ethylene glycol, diethylene glycol, ethylene dichloride, triethylene glycol, polyglycols, glycol ethers			C. J. Thomas	
Mathieson Chemical Corp. Lake Charles, La.	natural gas	anhydrous ammonia	69,000 ton/yr.		J. F. Newell	
Merichem Co. Houston, Texas	petroleum fractions	cresylic acid, phenol-cresol blends, sodium sulfide, sodium sulhydrate			J. T. Files, Vice Pres.	
Midland Rubber Co. Torrance, Calif.	butadiene, styrene	GR-S synthetic rubber	50,000 ton/yr.		I. W. Adams	
Mill Creek Chemical Co. Salt Lake City, Utah						See listing under Salt Lake Chemical Co.
Mississippi Chemical Corp. Yazoo City, Miss.	natural gas	anhydrous ammonia, ammonium nitrate	ammonia, 68,400 tons/yr.; ammonium nitrate, 81,000 tons/yr.	$13,000,000	W. B. Dunwoody, Gen. Op. Mgr.	Expansion program under way to raise ammonia production to 108,000 tons/yr., ammonium nitrate to 162,000 tons/yr. Scheduled date of completion Jan. '55. Total plant investment will then be $17,000,000.
Mississippi River Fuel Corp. Crystal City, Mo.	natural gas	anhydrous ammonia, nitric acid, ammonium nitrate	ammonia, 72,000 tons/yr. ammonium nitrate, 100,800 tons/yr.	$15,000,000	C. H. Lashlee, Pl. Mgr.	Under construction; completion scheduled for Oct. '55.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Mobay Chemical Co. (Monsanto Chemical Co.) St. Louis, Mo.	toluene	isocyanates			D. L. Eynon, Jr. Pres.	Newly-formed company, owned jointly by Monsanto and Farbenfabriken Bayer, A.G., Leverkusen, Germany. Plant location not yet determined.
Monsanto Chemical Co. Avon, Calif.	refinery gases and acid sludge	sulfuric acid	80,000 tons/yr.	$2,500,000	D. J. Miller	Joint operation with Tide Water Associated Oil Co. Sulfur is used as part of feed stock, in addition to the sludge and sour refinery gases.
Monsanto Chemical Co. Texas City, Texas	benzene, ethylene, methane, propane, natural gas	styrene monomer, vinyl chloride, acrylonitrile			H. K. Eckert, Pl. Mgr.	Polyethylene unit under construction; completion scheduled for late '54. Methanol unit to be operated by Monsanto and Heyden Chemical Corp. under construction; scheduled to begin operation late '54. Methanol capacity is 25,000,000 gal./yr. Polyethylene capacity is to be 66,000,000 lb./yr., with a 50% increase scheduled for 1957.
Morton-Withers Chemical Co. Greensboro, N. C.	petroleum fractions	petroleum sulfonates, synthetic lubes, lube oil additives	20,000,000 lb./yr. (total)		R. T. Masters, Supt.	Indicated capacity of 20,000,000 lb./yr. will be reached on completion of current expansion program by Dec. '54. Earlier plans for a new plant elsewhere have been revised to expansion at Greensboro only.
National Distillers Products Corp. Tuscola, Ill.	hydrogen	ammonia	50,000 ton/yr.	$7,000,000	D. Patterson	Under construction; scheduled for completion Jan. '55. Plant will operate on by-product hydrogen from adjacent National Petro-Chemicals Corp. ethylene plant.
National Petro-Chemicals Co. Tuscola, Ill.	natural gas	ethanol, ethyl chloride	ethanol, 40,000,000 gal./yr.; ethyl chloride, 50,000,000 lb./yr.	$50,000,000	D. J. Stark, Mgr.	Owned by National Distillers Products Corp. (60%) and Panhandle Eastern Pipeline Co. All units in operation since spring '54. Polyethylene plant now under construction; scheduled to begin operation early '55.
Natural Gas Odorizing Co. Houston, Texas	petroleum fractions	gas odorants			W. S. Cazort, Jr.	
Neches Butane Products Co. Port Neches, Texas	butylene	butadiene	197,000 ton/yr.		R. S. Crockett, Supt.	Government - owned plant, operated by Neches Butane Products Co., a joint venture of Atlantic Refining Co., Pure Oil Co., Gulf Oil Corp. and The Texas Co.
Neville Chemical Co. Anaheim, Calif.	petroleum fractions	hydrocarbon resins, aromatic solvents			R. L. Ulrich, West Coast Mgr.	

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Neville Chemical Co. Neville Island (Pittsburgh), Pa.	petroleum fractions	hydrocarbon resins, aromatic solvents			H. J. Shearer, Supt.	
Ninol Laboratories Chicago, Ill.	alkylated benzene	specialty sulfonates for detergents and emulsifiers	15,000,000 lb./yr.	$750,000	Jerome Kritchevsky, Pres.	
Northern Chemical Industries, Inc. Searsport, Maine	Bunker C fuel oil	anhydrous ammonia, nitric acid, ammonium nitrate solutions, nitraphosphate mixed fertilizer	ammonia, 45,000 ton/yr. nitric acid, 21,600 ton/yr. ammonium nitrate, 36,000 ton/yr. mixed fertilizer, 50,000 ton/yr.	$10,000,000	J. E. Totman Pres.	DPA certificate covers the anhydrous ammonia plant, utilizing a new patented process for obtaining the hydrogen through oxidation of Bunker C fuel oil. A letter of intent has been issued to Girdler Corp. for erection of all facilities except the mixed fertilizer unit. Northern Chemical Industries Inc. is an affiliate of Summers Fertilizer Co., Inc., Baltimore, Md.
Old Dutch Refining Co. Muskegon, Mich.					R. E. McCarty, Supt.	Company has been taken over by Aurora Gasoline Co. of Detroit, Mich. UOP Platforming unit of 1500 b/d capacity making motor fuel stocks only.
Oronite Chemical Co. Oak Point, La.	petroleum fractions	lube oil additives			T. I. Clausen	Subsidiary of Standard Oil Co. of Calif. Company is planning isophthalic plant at Richmond, Calif. Capacity at Oak Point plant is reported to be sufficient to treat 20,000 b/d of lubricants.
Pan American Refining Corp. Texas City, Texas	petroleum fractions	hydrocarbon plasticizers, polymers and resins, aromatic solvents, benzene, toluene, xylene	methyl mercaptan, 5,000,000 lb./yr.		B. F. Babin, Mgr.	
Pan-Am Southern Corp. El Dorado, Ark.	propane, propylene, butane, butylene	propylene tetramer, polybutene	polybutene, 2,000,000 gal./yr. tetramer, 3,800,000 gal./yr.		E. N. Kimes, Mgr.	
Pathfinder Chemical Co. Niagara Falls, N. Y.					F. Manchester	Now building $3½ million plant at Niagara Falls for manufacture of rubber accelerators made from synthetic rubber.
Pennsylvania Industrial Chemical Corp. Chester, Pa.	crude oil	butadiene, naphthalene, ethylbenzene, benzene, ethylene, isoprene, dicyclopentadiene, piperlene, isopropyl benzene			B. F. Schwelm, Mgr. J. D. Vermeychuk, Supt.	
Pennsylvania Industrial Chemical Corp. Clairton, Pa.	ethylbenzene, ethylene bottoms	styrene, petroleum resins			E. A. Taylor	New plant; full completion scheduled for end of '54.
Pennsylvania Refining Co. Karns City, Pa.	petroleum fractions	petroleum sulfonate	4,000,000 lbs./yr.	$500,000	John Beck	

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Petrocarbon Chemicals, Inc. Irving, Texas						Under construction; completion scheduled for near future. No further information available.
Petrochemicals Co. Long Beach, Calif.						Same as Universal Detergents, Inc. See listing under that name.
Petroleum Chemicals, Inc. (site undecided)					F. M. Simpson, Vice Pres. and Gen. Mgr.	A 50-50 partnership between Cities Service Refining Corp. and Continental Oil Co. No immediate plans; however, firm has bid on Lake Charles, La. butadiene plant as part of government's project for selling synthetic rubber plants
Phillips Chemical Co. Big Spring, Texas	mixed xylenes	para-xylene	5,000,000 lb./yr.		George Grimes, Supt.	In operation since Dec. '53. This plant is a para-xylene fractionation operation, using mixed xylenes from Udex unit at Cosden Petroleum Corp., Big Spring, Texas.
Phillips Chemical Co. Borger, Texas	butane, styrene	butadiene, synthetic rubber	butadiene: 71,200 ton/yr. rubber: 66,000 ton/yr.		A. B. Leonard, Supt.	Plant is government-owned, operated by Phillips.
Phillips Chemical Co. Borger, Texas	liquid hydrocarbons	furnace type carbon blacks	300,000,000 lb./yr.		A. J. Head, Supt.	
Phillips Chemical Co. Crane County, Texas	natural gas	sulfur	18,300 ton/yr.		A. F. Legatski, Supt.	In operation since Aug. '52.
Phillips Chemical Co. Etter, Texas	natural gas	anhydrous ammonia, ammonium nitrate, nitrogen solutions, nitric acid	ammonia: 154,000 ton/yr. nitrate: 140,000 ton/yr. solutions: 55,000 ton/yr.		C. W. Forman, Supt.	Ammonia plant is government-owned, leased to Phillips. Other facilities are owned and operated by Phillips.
Phillips Chemical Co. Goldsmith, Texas	natural gas	sulfur	36,500 ton/yr.		A. F. Legatski, Supt.	In operation since Feb. '52.
Phillips Chemical Co. Pasadena, Texas	natural gas	anhydrous ammonia, ammonium sulfate, methylvinylpyridine, acetaldehyde	ammonia: 150,000 ton/yr. Sulfate: 365,000 ton/yr. MVP: 2,000,000 lb./yr.	$29,000,000 on ammonia; $2,500,000 on MVP.	R. G. Rhodes, Supt.	
Productol Co. Santa Fe Springs, Calif.	petroleum fractions	phenols, cresols, cresylic acids, naphthalene			E. E. Chipman	
Pure Oil Co. Toledo, Ohio	petroleum fractions	toluene, xylene, aromatic fractions			H. H. Dronberger	
Pure Oil Co. (Smiths Bluff refinery) Nederland, Texas	petroleum fractions	lube oil additives			C. W. Cooper, Mgr.	
Purex Corp. South Gate, Calif.	propylene	sulfonated alkyl benzene			S. M. Dahl, Prod. Mgr.	
Purex Corp. St. Louis, Mo.	propylene	sulfonated alkyl benzene			B. Rich, Mgr.	

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Reichhold Chemicals Co. San Francisco, Calif.	petroleum fractions	synthetic resins				
Reichhold Chemicals Co. Andover, Mass.	petroleum methanol	formaldehyde				
Reichhold Chemicals Co. Detroit, Mich.	petroleum fractions	synthetic resins				
Reichhold Chemicals Co. Elizabeth, N. J.	benzene, petroleum fractions	maleic anhydride, synthetic resins				
Reilly Tar & Chemical Co. Newark, N. J.	petroleum fractions	phenol, cresylic acids			R. L. Comstock	
Republic Oil Refining Co. Texas City, Texas	petroleum fractions	benzene, toluene, xylene		$3,000,000	L. W. Robbie, Pl. Mgr.	In operation sinceNov. '53. New Platforming unit temporarily being operated for motor fuel rather than petrochemicals.
Richfield Oil Corp. (Watson refinery) Los Angeles, Calif.	refinery gases	ethylene			C. R. McKay	Under construction; completion was scheduled for Aug. '54.
Rohm and Haas Co. Houston, Texas	natural gas	hydrogen cyanide for methacrylate manufacture and chemical intermediates; carbon monoxide for acrylate manufacture			V. C. Henrich	
Roosevelt Oil & Refining Co. Mt. Pleasant, Mich.	petroleum fractions	benzene, toluene, aliphatic naphthas	benzene, 3,000,000 gal./hr. toluene, 2,400,000 gal./yr.		Tom Williams	
Salt Lake Chemical Co. Salt Lake City, Utah	natural gas	anhydrous ammonia, dry ice	ammonia: 42,000 ton/yr. dry ice: 10,500 ton/yr.	$8,000,000	J. B. Allinson, Pres.	New company formed to take over construction and operation of plant previously planned by Mill Creek Chemical Co. Completion scheduled for Dec. '55.
San Jacinto Chemical Corp. Houston, Texas	natural gas	ammonia	43,200 ton/yr.		D. A. White	$900,000 DPA certificate, 3/31/52 for expansion; no word from company as to present status.
Seaboard Oil Co. Powell, Wyo.	natural gas	sulfur 15,750 ton/yr.			John A. Tiehen, Supt.	
Shamrock Oil and Gas Corp. Sunray, Texas	acid gases	sulfur	10,800 ton/yr.		A. V. Beckworth, Supt.	
Sharples Chemicals, Inc. Wyandotte, Mich.	pentane, triisobutylene	amyl alcohol, amyl chloride, amyl acetate, amyl phenols, amyl naphthalenes, amyl mercaptan, tertdodecylmercaptan, polyethylene glycol tert-dodecylthioether			H. F. Bjork	
Shell Chemical Corp. Dominguez, Calif.	petroleum hydrocarbons	alcohols, solvents, other organic chemicals			O. M. Williams, Mgr.	Shell has a DPA-certificate for $400,000 for methyl isobutyl ketone at Dominguez.
Shell Chemical Corp. Martinez, Calif.	petroleum hydrocarbons	alcohols, solvents, other organic chemicals			E. W. Casagrande, Mgr.	

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Shell Chemical Corp. Pittsburg, Calif.	natural gas	ammonia, ammonium sulfate, carbon black, catalysts	ammonia: 109,500 ton/yr.		E. S. Bodine, Mgr.	
Shell Chemical Corp. Torrance, Calif.	butylenes	butadiene	61,000 ton/yr.		M. Voogd, Mgr.	Government - owned, operated by Shell.
Shell Chemical Corp. Ventura, Calif.	natural gas	anhydrous ammonia	65,000 ton/yr.	$10,000,000	F. D. Kuenzly, Mgr.	In operation since Dec 1953.
Shell Chemical Corp. Norco, La.	petroleum hydrocarbons	crude chlorohydrins, allyl chloride, D-D		$8,000,000	F. E. Caddy, Mgr.	Under construction; completion expected early '55. Shell has a DPA-certificate for $6,-900,000 for isopropyl alcohol facilities at Norco.
Shell Chemical Corp. Houston, Texas	petroleum hydrocarbons	alcohols, solvents, epon (R) resins, other organic chemicals	alcohols: 20,000,000 gal./yr.		Glenn Purcell, Mgr.	Shell has DPA-certificates for $9,000,000 for synthetic glycerine and $297,000 for acetone facilities at Houston.
Shell Oil Co. Martinez, Calif.	petroleum fractions	petroleum sulfonates			J. A. Tench	
Shell Oil Co. (Dominguez refinery) Wilmington, Calif.	petroleum fractions	benzene, toluene, xylene, cyclohexane	benzene: 6,000,000 gals./yr.		P. J. Merkus, Jr.	
Shell Oil Co. Wood River, Ill.	petroleum fractions	toluene, xylene			H. D. Dale, Mgr.	In operation since 1953.
Shell Oil Co. Houston, Texas	petroleum fractions	benzene, toluene	benzene: 19,000,000 gal./yr. toluene: 33,-000,000 gal./yr.		M. P. L. Love	Reported to be building a 55 ton/day sulfur unit.
Sid Richardson Carbon Co. Odessa, Texas	natural gas	channel type carbon blacks	80,000,000 lbs./yr.		H. H. Offutt	
Sid Richardson Carbon Co. Odessa, Texas	natural gas	sulfur	9000 tons/yr.	$190,000	G. M. Smith	Owned jointly by Sid Richardson and Odessa Natural Gasoline Co.; operated by Odessa.
Sid Richardson Gasoline Co. Kermit, Texas	natural gas	sulfur			D. H. Huff, Supt.	
Signal Oil and Gas Co. Tioga, N. Dak.	casinghead gas	sulfur, LPG propane, LPG butane		$14,000,000	L. C. Miller	Under construction; completion was scheduled for Aug. '54.
Sinclair Refining Co. Wood River, Ill.	petroleum fractions	aromatic solvents			M. H. Nolan, Mgr.	
Sinclair Refining Co. East Chicago, Ind.	petroleum fractions	lube oil additives, cresylic acids; gear, turbine and cutting oil additives			R. G. Arner	Manufacture of cresylic acids, discontinued in '52, was resumed in '54.
Sinclair Refining Co. Wellsville, N. Y.	petroleum fractions	petroleum resins			W. B. Chenault, Mgr.	
Sinclair Refining Co. Sand Springs, Okla.	petroleum fractions	demulsifying agents, corrosion inhibitors, acid-layer type petroleum sulfonate (sodium salt) oil-layer type petroleum sulfonate (sodium salt)				
Sinclair Refining Co. Marcus Hook, Pa.	catalytic reformate, petroleum fractions, refinery gas	toluene, para xylene, mixed xylenes, high aromatic solvents, dodecene, cresyl acids, sulfur	reformate: 1200 b/d sulfur: 7000 ton/yr.		R. J. Self, Mgr.	B-T-X facilities under construction; completion scheduled for spring, '55.

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Sinclair Refining Co. Corpus Christi, Texas	petroleum fractions	aromatic solvents			E. B. Killick, Mgr.	
Sinclair Refining Co. Houston, Texas	petroleum fractions, refinery gases	oil-layer type petroleum sulfonates (barium, calcium and sodium salts), corrosion inhibitors, odorless solvents, cresylic acids, sulfur	sulfur: 10,500 ton/yr.		J. D. Seifer, Mgr.	Sulfur recovery unit is under construction.
Sinclair Rubber Inc. Houston, Texas	butanes, butylenes	butadiene	78,000 ton/yr.		J. O'C. Brown, Mgr.	Government - owned plant operated by Sinclair Rubber Inc.
Socony-Vacuum Oil Co. Paulsboro, N. J.	petroleum fractions	benzonitrile			E. L. Sinclair	Manufacture of benzonitrile discontinued Dec. '53.
Socony-Vacuum Oil Co. Buffalo, N. Y.	petroleum fractions	sodium sulfite			C. M. Klaerner, Supt.	
Sonneborn, L., Sons, Inc. Petrolia, Pa.	petroleum fractions	petroleum sulfonates			H. Schindler, Mgr.	
Spencer Chemical Co. (Jayhawk Works) Pittsburg, Kans.	natural gas	anhydrous ammonia, methanol, ammoniating solutions, ammonium nitrate, nitric acid, carbon dioxide	ammonia: 178,000 ton/year		V. F. Hobart	
Spencer Chemical Co. (Henderson Works) Henderson, Ky.	natural gas	anhydrous ammonia	79,000 ton/yr.		R. D. Wallace, Wks. Mgr.	Additional facilities planned for production of nitric acid, ammoniating solutions.
Spencer Chemical Co. (Vicksburg Works) Vicksburg, Miss.	natural gas	anhydrous ammonia and ammoniating solutions	ammonia, 70,000 tons/yr.	$15,000,000	W. A. Johnston	In operation since Jan. '54.
Spencer Chemical Co. Orange, Texas	ethylene	polyethylene	45,000,000 lbs./yr.	$14,000,000	Frank Pyle	Under construction; completion scheduled for mid '55. Ethylene from Gulf Oil Co. refinery at Port Arthur, Texas.
Standard Oil Co. of Calif. El Segundo, Calif.	petroleum base stocks	benzene, toluene, paraxylene, cumene, butadiene-butylene mixtures, aliphatic acids, gas odorants	aromatics: 8740 b/d		D. K. Harger, Gen'l. Mgr.	Butadiene - butylene mixtures produced in government - owned plant operated by Standard of Calif.; crude butadiene-butylene mixture stream is shipped to government-owned butadiene plant at Torrance, operated by Shell Chemical Co., for further processing and refinement.
Standard Oil Co. of Calif. Richmond, Calif.	petroleum base stocks	ortho and para xylenes, industrial xylenes, alkyl aromatic detergents, metallic naphthenates and naphthenic acids, cresylic acids, petroleum sulfonates, polybutenes, gas odorants, ethyl mercaptans, phthalic anhydride, phenol, acetone	phenol: 35,000,000 lb./yr. acetone: 20,000,000 lb./yr.	$4,000,000 for phenol unit	R. K. Powell, Gen'l. Mgr.	
Standard Oil Co. (Ind.) Wood River, Ill.	Heptene, heart-cut from olefin feed, and other petroleum fractions	iso-octyl, nonyl, or higher alcohols; polybutene and high molecular weight hydrocarbons (lube-oil detergent additives and petroleum base plasticizers)	alcohols: 10,000,000 lb./yr.		H. E. Cotton	Alcohol plant went into operation early 1954.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETRO CHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Standard Oil Co. (Ind.) Whiting, Ind.	refinery gases and petroleum fractions	benzene, toluene, xylene, sulfur, detergent alkylate	10,000 B/SD dependanized hydroformates; paraxylene: 14,000,000 lb./yr. sulfur: 19,250 tons/yr.		A. F. Endres, Mgr.	Under construction; completion scheduled for June '55. New unit is conversion of an existing phenol extraction unit to a Udex extraction system. Production capacity anticipated is 845 B/SD benzene, 1,446 B/SD toluene, 712 B/SD xylenes.
Standard Oil Co. (Ind.) Sugar Creek, Mo.	petroleum fraction	C_7 olefin concentrate			H. R. Boehmer	
Standard Oil Co. (Ohio) Toledo-Lima area, Ohio	natural gas, hydrogen, (from reforming operations)	anhydrous ammonia, urea, nitric acid, nitrogen solutions	ammonia: 105,000 ton/yr. urea: 43,750 ton/yr. nitric acid: 21,000 ton/yr. solutions: 70,000 ton/yr.	$17,000,000		Construction to start this month, completion scheduled for late '55. Of total ammonia production, about 70,000 ton/yr. will be processed into other products.
Stanolind Oil and Gas Co. Brownsville, Texas	hydrocarbon synthesis chemical co-product stream	acetaldehyde, propionaldehyde, ethanol, n-propanol, n-butanol, acetone, methyl ethyl ketone, acetic acid, propionic acid			L. L. Smith, Supt.	Stanolind has acquired all of the stock of Carthage Hydrocol, Inc.; is in process of rehabilitating and expanding existing facilities. Scheduled completion date summer '55. (See also listing for Carthage Hydrocol, Inc.)
Stanolind Oil and Gas Co. North Cowden, Texas	natural gas	sulfur	6200 ton/yr.	$11,000,000	Errol R. Wagner, Supt.	
Stanolind Oil and Gas Co. Sundown, Texas	natural gas	sulfur	17,150 ton/yr.		H. K. Boswell	
Stanolind Oil and Gas Co. Elk Basin Field (Powell), Wyo.	natural gas	sulfur			A. H. Denny, Supt.	
Stauffer Chemical Co. Dominguez Jct., Calif.	refinery gases, acid sludge	sulfuric acid, sodium hydrosulfide			W. E. H. Knight, Mgr.	
Stauffer Chemical Co. Stege, Calif.	refinery acid sludge	sulfuric acid				
Stauffer Chemical Co. Hammond, Ind.	refinery acid sludge	sulfuric acid				
Stauffer Chemical Co. Louisville, Ky.	propane-propylene	carbon tetrachloride perchlorethylene		$3,600,000	H. L. McLean, Supt.	Completed Feb. '54.
Sun Oil Co. Toledo, Ohio	refinery streams, tail gas from reformer	butylenes, propylene trimer, propylene tetramer, hydrogen			John F. Harron	
Sun Oil Co. Marcus Hook, Pa.	petroleum fractions	benzene, toluene, xylene, petroleum sulfonates, naphthenic acids, propylene trimer, and propylene tetramer	benzene, 19,000,000 gal./yr.; toluene, 30,000,000 gal./yr.; xylenes, 18,000,000 gal./yr.	$15,000,000 (aromatics plant)	W. T. Askew, Mgr.	
Sunray Oil Corp. Duncan, Okla.	petroleum fractions	propylene tetramer			R. C. Underwood, Supt.	

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Suntide Refining Co. Corpus Christi, Texas	petroleum fractions	propylene tetramer			A. T. Smith, Supt.	In operation since Jan. '54.
Taylor Oil and Gas Co. Corpus Christi, Texas	crude oil and crude distillate				F. A. Reneau, Supt.	Refinery not presently operating as a petrochemical plant. Aromatics now used in motor fuel.
Texas Butadiene & Chemical Corp. Houston, Texas	n-butane	butadiene, alkylate, butylenes	40,000 ton/yr. butadiene	$30,000,000	R. L. Purvin, Pres. (Dallas, Texas)	Company recently formed. Exact site not yet selected. Construction contracts not let. Participants in new firm include Fluor Corp., Carl M. Loeb, Wm. R. Staats Co., Warren Petroleum Corp., Wertheim & Co.
Texas Eastman Company Division of Eastman Kodak Company Longview, Texas	ethane, propane, natural gas	n-butyraldehyde, isobutyraldehyde, ethanol, ethylhexyl alcohol, polyethylene and chemical intermediates	polyethylene: 20,000,000 lbs./yr.	$10,800,000	D. C. Hull, Vice Pres. & Mgr.	Polyethylene plant under construction; completion scheduled for end of '54. Products will be used as raw materials at the Kingsport, Tenn. plant of Tennessee Eastman Co., Div. of Eastman Kodak Co. for acetate yarn, plastic, industrial chemicals and sale (through Eastman Chemical Products, Inc.)
Texas Gas Corp. Winne, Texas	natural gas	methanol, acetaldehyde, formaldehyde			Paul Bearden, Mgr.	Part of plant in use to supplement facilities in adjacent motor gasoline and LPG plant. Plant in stand-by and could be returned to operation at any time.
Texas Gulf Sulphur Co. Worland, Wyo.	natural gas	sulfur	108,000 tons/yr.		C. E. Butterworth	
Thermatomic Carbon Co. Sterlington, La.	natural gas	carbon black			R. W. Cretney, Vice Pres. & Gen. Mgr.	
Union Oil Co. of Calif. Oleum, Calif.	refinery gases and wastes	sulfur	18,250 tons/yr.	$600,000	J. W. Towler	Plant in engineering stage; completion scheduled for Feb. '55.
Union Oil Co. of Calif. Santa Maria, Calif.	natural gas	dry ice and liquid carbon dioxide	18,250 tons/yr.	$825,000	W. O. Butler	
Union Oil Co. of Calif. Wilmington, Calif.	refinery gases and wastes	methyl and ethyl mercaptans	500,000 lbs./yr.	$200,000	H. C. Meiners	
Union Oil Co. of Calif. Wilmington, Calif.	refinery gases and wastes	sulfur	17,000 tons/yr.	$600,000	H. C. Meiners	
Union Oil Co. of Calif. Wilmington, Calif.	refinery gases and wastes	ammonium sulfate	18,000 tons/yr.	$1,000,000	H. C. Meiners	
United Carbon Co. Ryus, Kans.	natural gas and oil	furnace carbon blacks			Grant Thomas, Charleston, W.Va.	
United Carbon Co. Franklin, La.	natural gas and oil	furnace carbon blacks			Grant Thomas, Charleston, W.Va.	
United Carbon Co. Rayville, La.	natural gas	channel carbon blacks			Grant Thomas, Charleston, W.Va.	

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
United Carbon Co. Swartz, La.	natural gas	channel carbon blacks				Plant is not operating.
United Carbon Co. Eunice, New Mex.	natural gas	channel carbon blacks			Grant Thomas, Charleston, W.Va.	
United Carbon Co. Aransas Pass, Texas	natural gas and oil	furnace carbon blacks channel carbon blacks			Grant Thomas, Charleston, W.Va.	
United Carbon Co. Borger, Texas	natural gas	channel carbon blacks			Grant Thomas, Charleston, W.Va.	
United Carbon Co. Falfurrias, Texas	natural gas	channel carbon blacks			Grant Thomas, Charleston, W.Va.	
United Carbon Co. Shamrock, Texas	natural gas and oil	furnace carbon blacks			Grant Thomas, Charleston, W.Va.	
United Carbon Co. Stinnett, Texas		channel blacks				
United Chemical Co. Timpson, Texas	natural gas	ammonia, urea	ammonia, 57,600 ton/yr. urea, 115,200 ton/yr.	$18,000,000		In planning stages: company plans to have ground-breaking Sept. '54, estimates 18–20 months for completion.
U. S. Rubber Co. Naugatuck, Conn.	butadiene, styrene	GR-S synthetic rubber	22,200 ton/yr.		P. E. Rice	
U. S. Rubber Co. Joliet, Ill.		undisclosed				Information restricted under government security regulations.
U. S. Rubber Co. (Naugatuck Chemical Div.) Baton Rouge, La.		nitrile type synthetic rubbers, plastics and molding powders			J. S. Brown	
U. S. Rubber Co. Port Neches, Texas	butadiene, styrene	GR-S synthetic rubber	100,000 ton/yr.		T. A. McCoy, Mgr.	Government - owned plant, operated by U.S. Rubber.
Universal Detergents, Inc. Long Beach, Calif.	petroleum fractions	alkyl aryl sulfonates and aromatic solvents	sulfonates, 4,320 tons/yr. aromatic solvents, 60,-000 bbl./yr.	$1,000,000	B. R. Bryant, Gen. Mgr.	
Utah Chemical Co. Mt. Pleasant, Utah	natural gas	anhydrous ammonia, nitric acid, ammonium nitrate	ammonia, 100,000 ton/yr. nitric acid, 176,000 ton/yr. ammonium nitrate, 361,-320 ton/yr.	$18.800,000	N. G. Morgan, Jr., Pres.	Under construction.
Velsicol Corp. Marshall, Ill.	petroleum base stocks	benzene, toluene, xylenes, petroleum polymers, condensate resins			W. Camp	
Visco Products Co. Sugar Land, Texas	petroleum fractions	oil treating chemicals			E. T. Kocher	Under construction; completion scheduled for Jan. '55.
Warren Petroleum Corp. Monument, New Mex.	natural gas	sulfur			L. A. Walker, Supt.	Plant owned by Allied Chemical & Dye Corp., operated by Warren.
Warren Petroleum Corp. Conroe, Texas	butane, propane	peutaerythritol, methyl alcohol, acetaldehyde	pentaerythritol, 2,500,-000 lbs./yr. methyl alcohol, 4,000,000 lbs./yr. acetaldehyde, 2,000,000 lbs./yr.	$2,000,000	E. Harper	LPG from Warren-owned Midland Gasoline Co. at Conroe. In operation July '54.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
Warwick Wax Co., Inc. Chanute, Kans.	B S & W sludge from oil storage tank bottoms	petroleum waxes — microcrystalline, polymerized, and oxidized types			G. Hatfield	
Westvaco Chlor-Alkali Div. (Food Machinery and Chemical Corp.) South Charleston, W. Va.	natural gas	carbon bisulfide				In operation since Feb. '54.
Wilshire Oil Co. Norwalk, Calif.	refinery gases	sulfur	5400 ton/yr.	$175,000	J. H. Onding	In operation since June '53.
Witco Carbon Co. Eunice, N. Mex.	natural gas	rubber channel blacks			O. M. Middlebrooks, Mgr.	
Wyandotte Chemicals Corp. Wyandotte, Mich.	crude petroleum and petroleum fractions	ethylene glycol, diethylene glycol, ethylene dichloride, chlorinated solvents, alkyl aryl sulfonate, synthetic detergents, sodium carboxymethylcellulose, "B.H.C.," DDT (Technical), lindane			F. B. Wolcott	
Wynn Oil Co. Azusa, Calif.	petroleum fractions	lube oil additives			A. Foss, Prod. Mgr.	

Petrochemical Plants in Canada

B. A.-Shawinigan Ltd Montreal, Quebec	cumene	phenol, acetone	phenol, 13,000,000 lbs./yr. acetone, 8,000,000 lbs./yr.	$4,000,000	R. H. Hall, Mgr.	Company is jointly owned by British American Oil Co. and Shawinigan Chemicals Ltd.
Bakelite Corp. Belleville, Ont.	methanol	formaldehyde				
British American Oil Co. Montreal, Quebec	refinery gases	cumene			J. A. McHardy	
British Dominion Oil Co. Alberta (?)	natural gas	ammonium nitrate fertilizers		$18,000,000		Plans announced in mid-August, indicated location to be southern Alberta.
Cabot Carbon Co. of Canada, Ltd. Sarnia, Ontario	petroleum fractions	oil furnace blacks	35,000,000 lbs./yr.	$3,500,000	W. F. Hendricks, Res. Mgr. J. A. Satterfield, Supt.	In operation since Mar. '53.
Canadian Industries (1954) Ltd. Edmonton, Alberta	natural gas	polyethylene	16,000,000 lbs./yr.		J. D. Wright	
Consolidated Mining & Smelting Co. of Canada Ltd. Calgary, Alberta	natural gas	ammonia, ammonium nitrate			R. S. Woodford, Gen. Supt.	
Dow Chemical of Canada Ltd. Sarnia, Ontario	refinery gases	ethylene, ethylene oxide, ethylene glycol, styrene, carbon tetrachloride, ammonia, trichlorethylene, perchlorethylene latices, chlorine-caustic, polystyrene and other organic chemicals			Paul D. Scott, Works Mgr.	

COMPANY AND PLANT LOCATION	HYDRO-CARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	CAPACITY	APPROX. INVESTMENT	MANAGER OR SUPERINTENDENT	REMARKS
du Pont Company of Canada Ltd. Maitland, Ont.	cyclohexane	hexamethylene diamine and adipic acid			A. T. Fell	Company's name changed from Canadian Industries Ltd., July 1, 1954.
Imperial Chemical Industries of Canada Ltd. Millhaven, Ont.	ethylene glycol, dimethylester of terephthalic acid	"terylene"	11,000,000 lbs./yr.	$20,000,000		
Lubrizol of Canada, Ltd. Niagara Falls, Ontario	petroleum fractions	lube oil additives			M. A. Payne	
Monsanto Canada Ltd. Montreal, Que.	petroleum base stock	polystyrene			H. Dixon	
S. Nord Chemical Co. Petrolia, Ont.	catalytic reformate	benzene, toluene, xylenes, high flash point naphthas	aromatics: 2000 b/d	$1,500,000	Sol Nord, Mgr.	
Polymer Corporation Limited Sarnia, Ontario	refinery gases	styrene monomer, ethylene, isobutylene, synthetic rubbers of buyl and butadiene types	80,000 ton/yr.	$70,000,000	L. D. Dougan, Pl. Mgr.	Raw material from Imperial Oil Ltd., Sun Oil and Canadian Oil at Sarnia, Sun Oil at Toledo, Ohio.
Royalite Oil Co. Ltd. Turner Valley, Alberta	natural gas	sulfur	14,400 tons/yr.		T. W. Trotter	
St. Maurice Chemical Co. Varennes, Que.	methanol, acetaldehyde	formaldehyde, pentaerythritol				
Shell Oil Co. of Canada, Ltd. Jumping Pound, Alberta	natural gas	sulfur	10,800 ton/yr.		T. B. Smith	Expansion program under way to increase annual output to 28,800 LT/yr. Scheduled for completion Nov. '54.
Shell Oil Co. of Canada, Ltd. Montreal, Quebec	refinery gases, propylene	isopropyl alcohol, acetone	20,000,000 lbs./yr.	$4,000,000	G. S. Williamson, Supt.	
Sherritt Gordon Mines, Inc. Fort Saskatchewan, Alberta	natural gas	ammonia, ammonium sulphate	27,000 tons/yr.	$24,000,000	Sydney Nashner	New plant, in operation since June '54. Ammonia produced for use in treatment of nickel concentrates from company's mine at Lynn Lake, Man. Ammonium sulphate to be produced at a rate of 72,000 tons/yr. as a byproduct of treatment process.
Standard Chemical Co. Ltd. Division of Dominion Tar & Chemical Co., Ltd. Montreal East, Quebec	ethane, ethylene	ethylene oxide, ethylene glycol, diethylene gylcol, ethylene, dichloride, dichloroethyl ether			J. C. Langford	In operation since May '53.
Sun Oil Co., Ltd. Sarnia, Ont.	refinery streams	butylenes			G. R. Henderson	
Surpass Petrochemicals Ltd. Scarborough, Ont.	petroleum fractions	rust preventives, engine oil additives				Existing plant has a worth set at about $140,000. Company is developing plans for early expansion, possibly early-1955, to extent of additional $250,000 investment. Surpass at one time had purchased Alox Corp., Niagara Falls, N. Y., but has since re-sold that firm to original owners.

Westoil San Pedro Terminals

These West Coast Storage Facilities Can Be Yours!

To help your company develop new markets in the growing Golden West—or to better serve your present markets—Westoil offers you the facilities of eight strategically located terminals on the West Coast.

All terminals are equipped to handle any liquid that flows through a pipeline—to provide tanks, pipelines, docks, loading racks, drumming and canning facilities, as well as labor, supervision and administration.

You have the privacy and convenience of your own company terminal—*with no investment in equipment, storage, property or dock facilities.*

Westoil warehouse receipts represent the highest form of collateral.

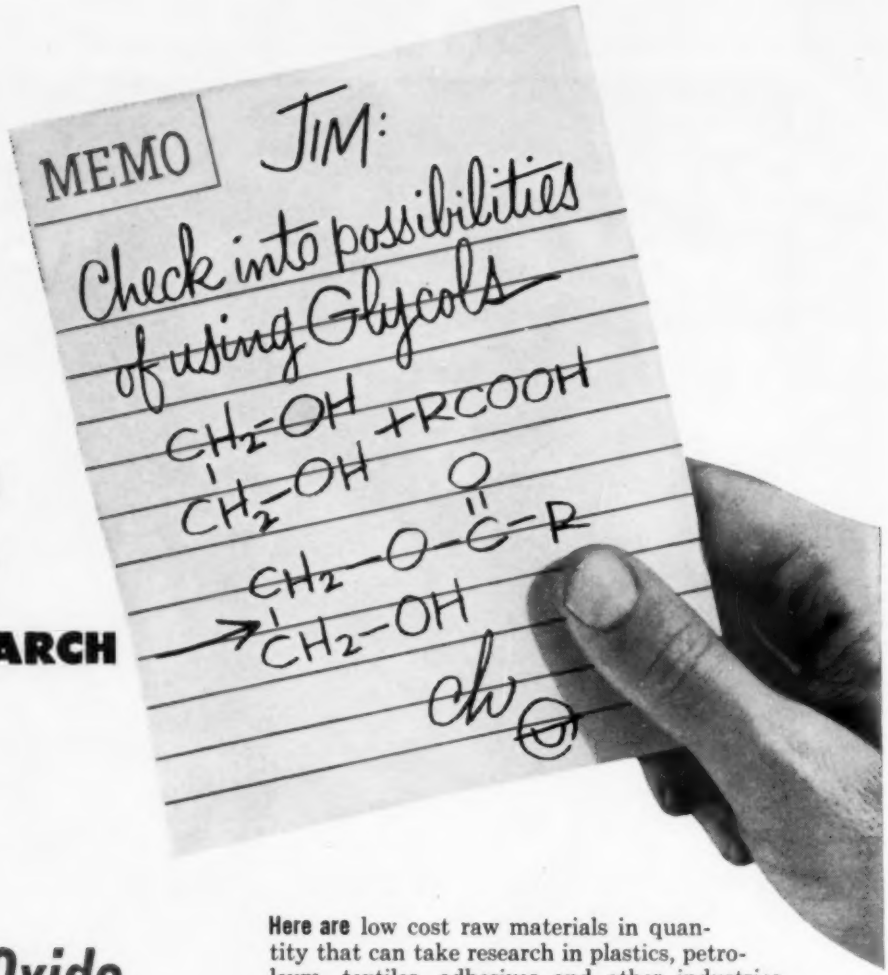
We would like to discuss your West Coast liquid storage and distribution problems with you. Let us show you how we can save you time and money. Write, wire or telephone us:

WESTOIL TERMINALS CO.

GENERAL OFFICES
2221 So. Olive St.
Los Angeles 7, Cal.
Richmond 7-4331

TERMINALS IN:
LOS ANGELES • SAN FRANCISCO • RICHMOND • STOCKTON
SACRAMENTO • PORTLAND • TACOMA • SEATTLE

 (To obtain more data on advertised products see page 1464)



NOW

IS THE TIME

TO STEP UP

YOUR RESEARCH

ON

NITROGEN DIVISION ALLIED CHEMICAL

Ethylene Oxide
Ethylene Glycol
Diethylene Glycol
Triethylene Glycol

Here are low cost raw materials in quantity that can take research in plastics, petroleum, textiles, adhesives and other industries from the laboratory stage to actual, profitable production. Recent sharply reduced selling prices on these organics may now turn your new project idea into a profitable venture!

Our large, new Orange, Texas, petrochemicals plant can meet your needs—present and future—for highest possible commercial purity in Ethylene Glycol, Diethylene Glycol, Triethylene Glycol and Ethylene Oxide. This high, consistent purity is assured because these products are made by the improved *direct oxidation* process. Shipments are available in drums, tank wagons, and 4, 6, 8, and 10,000-gallon tank cars.

Can we help you? Call us. Our Technical Service staff can assist you in adapting these high purity materials to your production. A 33-page Technical Bulletin is available, containing the latest information on the properties, reactions, uses, handling and storage of Ethylene Oxide, Ethylene Glycol and Diethylene Glycol. Write for it today.

NITROGEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.

Ironton, Ohio • Orange, Texas • Omaha, Nebraska

Ammonia • Sodium Nitrate • Urea • Ethylene Oxide • Ethylene Glycol
Diethylene Glycol • Triethylene Glycol • Methanol • Formaldehyde
Nitrogen Tetroxide • U.F. Concentrate—85 • Nitrogen Solutions
Fertilizers & Feed Supplements

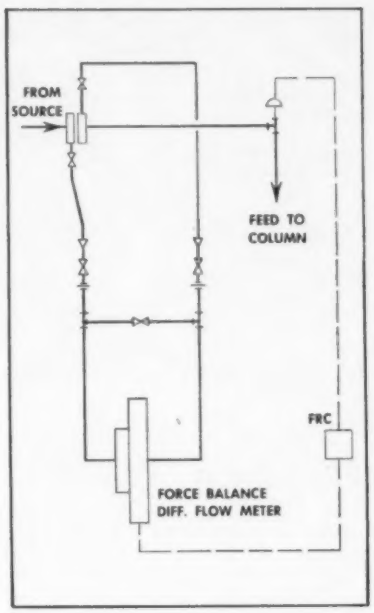


FIG. 1—Orifice type differential pressure system for muriatic acid stream to distillation column

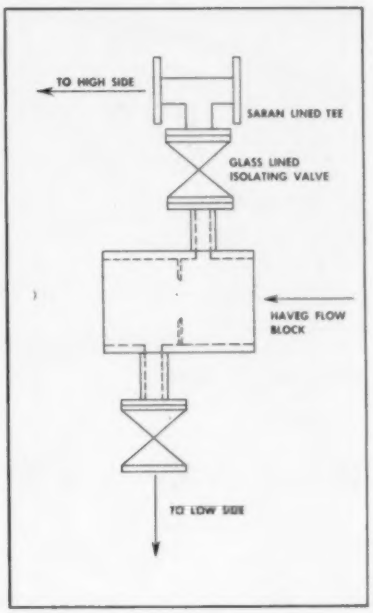


FIG. 2—Orifice "flow block" made of Micarta and using steel orifice resists corrosion

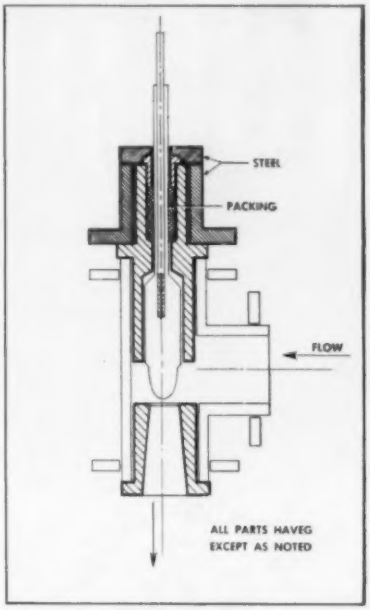


FIG. 3—Control valve for regulating the muriatic acid flow is constructed of Haveg

How to Measure and Control HCl Streams

BY J. F. DAVIS
Monsanto Chemical Co.*

IN most petrochemical plants, such as that of Monsanto Chemical Co. at Texas City, the uses of "hard-to-measure-and-control" materials are increasing.

It almost seems as though the first step the research people take in the development of a new product is to check each of its components to make sure they are in a higher corrosive action bracket than any which have been handled in the past. The results of their efforts tend to make the instrument men lose their hair trying to find ways and know-how to measure and control these brain children.

Since it looks as if we in the instrument field are stuck with these unruly babies for a long time, I should like to offer one solution to some of these troublesome problems.

Consider the problem of measuring and controlling a muriatic acid stream. For certain reasons, we preferred to use the orifice-type, differential measuring system shown in Fig. 1. We know that if accuracy of measurement was to be obtained we had to conform to accepted metering practices. We reasoned that the most practical orifice run for us to build would be one employing flange taps, since we did not have the facilities for tapping a glass-lined pipe needed for pipe or vena-contracta taps.

A check was made on the materials which were inert to muriatic acid at normal ambient temperatures. Thought had to be given to selecting a material which could be machined easily, that could withstand pressure, and yet be reasonably economical. We found that No. 221A Micarta would fill this bill.

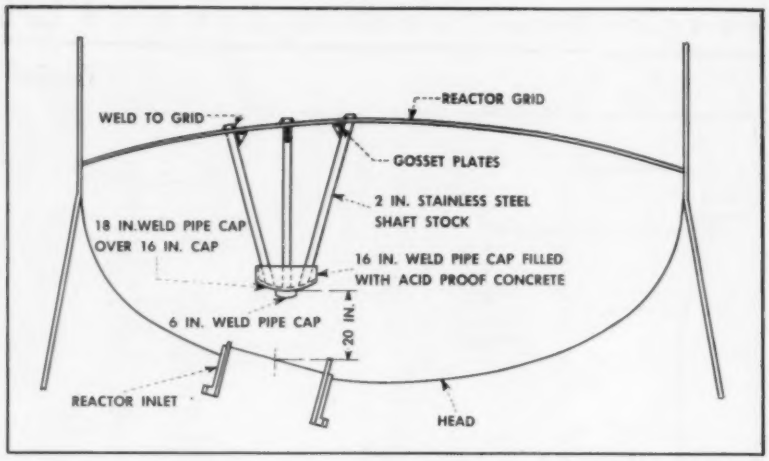
The orifice plate and flange taps assembly, which we call an "orifice flow block," was designed and machined according to the details shown in Fig. 2. The internal diameter of the flow block is machined to the same I.D. as that of the pipe. The block is installed in the line by using Van Stone flanges.

For simplicity in installing the orifice tap valves and sealing tees, which are glass-lined, the orifice taps are placed 180° apart and 1 in. from the upstream and downstream faces of the orifice plate. The orifice plate itself is ¼-in. thick, and the dam is ⅛-in. thick.

A conventional, force-balance, differential-pressure flow meter was used to eliminate sealing pots. Piping from the flow block to the meter body is ½-in., Sched. 80, black seamless pipe. A fluorocarbon was used as a sealing medium. It is inert to the muriatic acid, has a high specific gravity and high boiling point.

The control valve is similar to one designed by V. A. Riggio, an instrument engineer with Monsanto in St. Louis. It is illustrated in Fig. 3. This valve is constructed of "Haveg 60," and as is apparent from the drawing, the Haveg is the only material coming into contact with the corrosive stream of acid. This system has proved very satisfactory and has a minimum amount of maintenance problems.

*Mr. Davis is instrument engineer at Monsanto Chemical Co., Texas City, Texas. This short article is taken from his paper, "Differential Measurement and Control of Corrosive Streams," presented in a symposium during the Instrumentation for the Process Industries Short Course at Texas A&M College, Jan., 1954.


WELD TO GRID
REACTOR GRID
GOSSET PLATES
2 IN. STAINLESS STEEL SHAFT STOCK
18 IN. WELD PIPE CAP OVER 16 IN. CAP
16 IN. WELD PIPE CAP FILLED WITH ACID PROOF CONCRETE
6 IN. WELD PIPE CAP
20 IN
REACTOR INLET
HEAD

MORE UNIFORM WEAR over entire reactor grid results from "deflector" located over catalyst riser inlet

Want to Reduce Reactor Grid Wear?

A "TARGET" device, or deflector, installed below the grid in a Fluid catalytic cracking unit reactor and directly above the catalyst riser inlet, has proved to be an efficient erosion safeguard for one midwestern refiner.

National Cooperative Refinery Association, at its McPherson, Kans., refinery, had found that after a single year of operation about 50% of the metal thickness was worn away in the center area of the grid on its underside. By installing the target, as shown in the accompanying drawing, they have been able to realize an additional two years of useful life from the grid.

Built from materials readily available around the shop, the target device consists essentially of some pipe caps of various sizes suspended below the grid and over the reactor inlet. The supports are 2-in. stainless steel shaft stock, welded and gusseted to the grid, and arranged in an inverted "tripod" form. The target comprises a 16-in. weld pipe cap filled with acid-proof concrete and enclosed within an 18-in. weld pipe cap. Another weld pipe cap, of 6-in. diameter, is fastened to the center of the 18-in. cap.

Incoming flow is deflected away from the center area of the grid as a result, and wear is made more uniform over the entire grid.

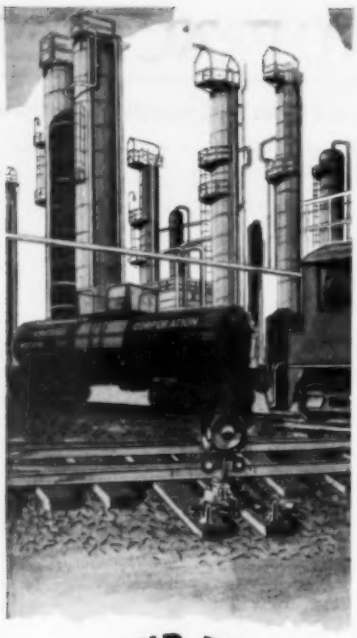
Note: the preceding short article is based on information in the paper, "Refinery Maintenance Turnaround," by John Early, National Cooperative Refinery Ass'n., McPherson, Kans., and presented at the Wichita, Kans., regional meeting of the Western Petroleum Refiners Ass'n. in May.

Stopping Overhead Condenser Attack

Problem: Corrosion in a bubble tower overhead condenser: shell is carbon steel, and tubes are Admiralty (0.083-in. wall). Severe pitting occurred on tubes below the inlet nozzle in two to three years, rendering them useless. Steel shell showed signs of pitting below inlet nozzle and near the baffles. Service conditions were: corrosive, cracked distillate vapor containing sulfur and water; temperature, 325° F.; pressure, 60 psi.; aeration, none.

Suggested solution: It is believed the pitting of the mild steel is due to the presence of hydrochloric acid and the pitting of the Admiralty tubes is due to a combination of hydrochloric acid corrosion *and* erosion from velocity effects. The substitution of Monel or Monel-clad steel would overcome the difficulties encountered with the shell, and the replacement of the tubes with Monel or high iron, 70-30 cupronickel would eliminate the erosion as well as minimize the corrosion problem.

The preceding article is based on information developed in a conference in Montreal for representatives of several Canadian oil companies and of International Nickel Co. of Canada Ltd. It was prepared for PETROLEUM PROCESSING by John F. Mason, Jr., corrosion engrg. section, development and research dept., International Nickel Co., New York. A major portion of Mr. Mason's work appeared in an article in the Sept., 1953, issue, pp. 1332-1335.



SULPHUR-DIOXIDE
HIGHEST QUALITY
SO_2

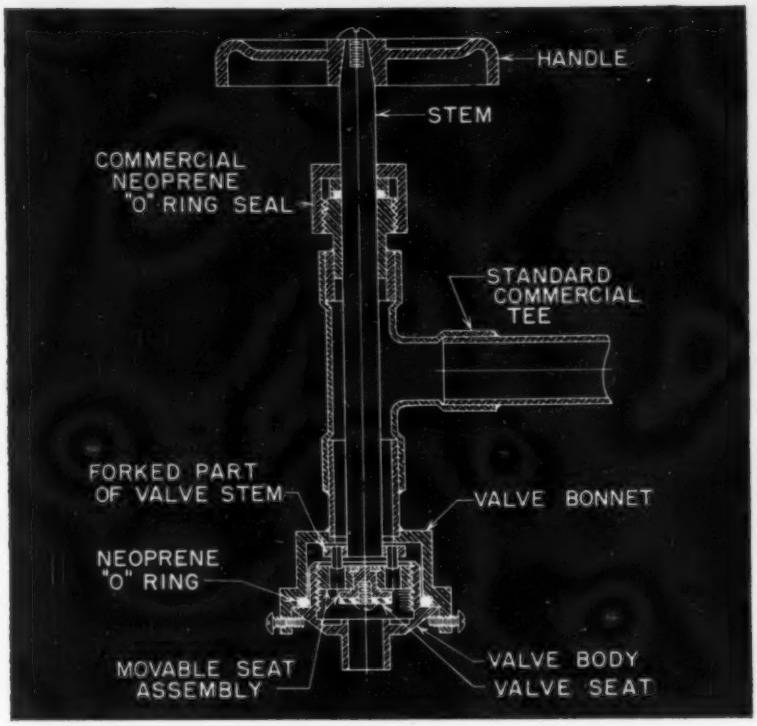
Side-Track To Successful Operations

Forward-looking industries have found Tennessee's highest quality Sulphur-Dioxide a sure side-track to successful operations. In so many cases, highly efficient and economical operations can be attained through the uses of this chemical (SO_2) with its multi-purposed versatility. We can supply Tennessee's highest quality Sulphur-Dioxide in cylinders, ton drums, tank cars and tank trucks. Let our experienced technicians show you how you might utilize it to your best advantage.

CONTAINERS—
- Cylinders
- Ton Drums
- Tank Trucks
- Tank Cars

Samples, Specifications and Detailed Information on Request.

TENNESSEE CORPORATION
617-29 Grant Building, Atlanta, Georgia



New Valve Improves Vacuum Safety

A new seal-off valve with a number of advantages for high-vacuum work has been devised recently at the National Bureau of Standards. It is so designed that its handle and stem can be readily removed and used with any number of seal-off seats, leaving only the closed valve seat on the evacuated apparatus.

In this way, the vacuum system is protected from the atmosphere at all times, yet the bulkiness of a complete permanent valve is avoided. The device is also well adapted to use as a pressure seal or as a combination safety valve and seal-off valve. It is now being used for high-vacuum applications in work sponsored by the Atomic Energy Commission at the NBS-AEC cryogenic Engineering Laboratory.

Common practice on vacuum seal-off has been either by installing a complete valve or by pinching off annealed metal tubing, with or without the use of solder. Both types of tubing seals require the soldering or welding of a new piece of tubing into the system each time it is evacuated. This not only results in exposure of the system to the atmosphere but often presents difficult problems of manipulation. A complete valve is objectionable because it is frequently an awkward protuberance on a small piece of apparatus.

The new NBS valve provides a permanent pumping tap that can be used many times without soldering or welding. Principal parts are a valve handle and stem, the valve body and seat, and a removable bonnet enclosing the seat assembly and adjacent end of the stem. (See drawing.)

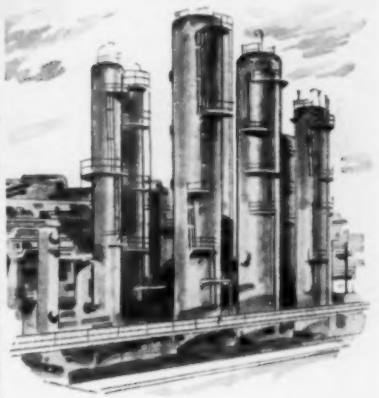
The movable seat contains six ports through which the vacuum system is pumped out. Attached to this end of the stem is a narrow bar which contains two small pins equidistant from the axis of the stem. When the desired vacuum has been attained, the pins are made to engage two of the ports in the seat, and the handle is turned until the valve is seated. The screws of the bonnet are then loosened, and all the parts except the movable seat assembly are removed as a unit. A rubber or plastic cap may be used to protect the remaining parts from dirt. When the static vacuum space requires pumping again, the removable parts are replaced, the bonnet screws are tightened, and the valve handle is turned to open the valve.

Because of the very short ports in the valve, the valve body can be made very small without sacrificing pumping speed. The parts can be made of any suitable material, but a neoprene seat is recommended for use on high-vacuum systems.

DE LUXE MODEL

$49,000,000.00

LEAK DETECTOR



While this leak-detecting device carries a $49,000,000.00 price tag, it is worth every penny of it! This device will not find leaks any faster than lower-priced models, but it will usually find more of them.

Leaks are expensive. Why not specify Swagelok Fittings and stop leaks before they happen?

Write for the Swagelok Catalog today. Address Department 62.

Swagelok®

TUBE FITTINGS

BRASS • ALUMINUM • STEEL

STAINLESS STEEL • MONEL

CRAWFORD FITTING CO.

884 E. 140th Street

Cleveland 10, Ohio

New Grease Thickener...
Estersil GT
by Du Pont
A new type of grease thickener—quite different from any previously used in commercial grease production—was recently announced by the Petroleum Chemicals Division of the Du Pont Company.
The new material, an estersil, is a pelletized form of finely divided amorphous silica with a "raincoat" chemically attached to each tiny ultimate particle.
Formerly known as PL-171 FINE SILICA, it is completely synthetic and was specially developed for grease compounding. "Built-in" water resistance and exceptional thermal stability are among its unusual and outstanding properties.
NOW—with Estersil GT you can easily prepare a unique multi-purpose grease with the basic advantages listed below . . .

1. Excellent Thermal Stability—Nonmelting Estersil GT greases show little change in consistency over a wide range of operating temperatures.

2. Excellent Shear Stability—This new thickener enables you to make greases with exceptional shear stability under *both* normal and *high* temperature conditions.

3. Water Resistance—The chemically bonded "raincoat" means greases with unusual resistance to wash out or break down in the presence of water.

4. Superior Oxidation Stability—The need for grease antioxidants is eliminated under most service conditions because of the inertness of Estersil GT.

5. Superior Handling Qualities—Softer, more easily applied greases can be used for high temperature service because of the combined mechanical and thermal stability imparted by Estersil GT. These softer greases, of course, are more readily handled at low temperature than the more conventional types.

6. Ease of Manufacture—The completely synthetic preformed thickening structure allows reproducible grease preparation through a simple milling operation.

Du Pont will be glad to send a representative to discuss the formulation of improved greases with Estersil GT. A grease pilot plant is available to assist in this work. Samples of Estersil GT may be obtained by addressing your inquiry to Wilmington, Delaware.

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living . . . through Chemistry

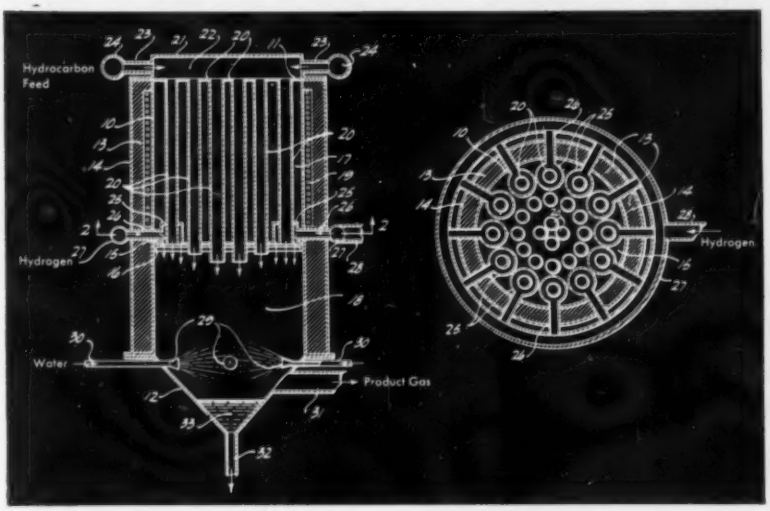
Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

Regional Offices:
NEW YORK, N. Y.—1270 Ave. of the Americas . . . Phone COlumbus 5-3620
CHICAGO, ILL.—8 So. Michigan Blvd. . . . . Phone RAndolph 6-8630
TULSA, OKLA.—1811 So. Baltimore Avenue . . . . . Phone Tulsa 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. . . . . Phone PReston 2857
LOS ANGELES, CALIF.—612 So. Flower St. . . . . Phone MAdison 5-1691

IN CANADA: Du Pont Company of Canada Limited—Toronto, Ont.—Montreal, Que.—Calgary, Alta.
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Building 6539—Wilmington 98, Del.

By Peter J. Gaylor, Patent Attorney, Elizabeth, N. J.



REACTOR for producing acetylene by partial oxidation of hydrocarbons

Partial Oxidation Process Useful For Acetylene-From-Hydrocarbons

A NUMBER of patents have been obtained by Union Oil Co. of California on the production of acetylene by partial oxidation of hydrocarbons, which indicates that the company has done considerable work in this direction.

Acetylene is produced by preheating a reactant gas mixture containing a hydrocarbon and oxygen, admixing hydrogen with the preheated gas mixture, whereupon an exothermic reaction occurs with a consequent increase in temperature to between 1100 and 1500°C. Thereafter, the resultant hot product gas is quench-cooled to a relatively low temperature within a very short period of time.

The preheat temperature is so controlled that the requisite high reaction temperature is derived entirely from the exothermic heat of reaction, without any other addition of heat. This type of operation is said to give relatively high yields of acetylene based on the quantity of hydrocarbon consumed and is particularly attractive from the standpoint of chemical cost, since air may be employed as the source of oxygen, and the hydrocarbon may be low-cost natural gas. Also, thermal requirements are lower than those of prior partial oxidation processes, since lower preheat temperatures are employed and no heat need be supplied directly to the reaction from exterior sources. Carbon black formation is practically nil. The most significant feature of the process is the use of hydrogen to initiate the acetylene - producing reaction. There is no overall consumption of hydrogen and, generally, the product contains more hydrogen than was originally added to the preheated reactant gas, so that the use of hydrogen is said not to add to the chemical costs involved when recovered hydrogen is used. However, it is usually necessary to recycle 5 to 10 volumes of hydrogen per volume of acetylene produced, and even though the hydrogen may be employed in admixture with certain other components of the product gas the cost of separating and handling this quantity of hydrogen constitutes a very material part of the total cost of acetylene produced by this process.

In U. S. Patent 2,679,542, a method is disclosed whereby the amount of hydrogen needed may be materially reduced by allowing the hydrogen to form a gaseous layer or film along the walls of a reaction zone into which the preheated reactant gas is introduced in a plurality of separate streams. The amount of hydrogen to be used is substantially reduced by preheating the reactant gas in a plurality of separate streams and introducing the streams of preheated gas into the central portion of a common reaction zone while introducing hydrogen into the reaction zone adjacent to its periphery, so that a gaseous film of hydrogen is interposed between the walls of the reaction zone and the major portion of the preheated reactant gas entering the reaction zone. In this manner, the amount of hydrogen supplied per volume of acetylene produced may be reduced by one-half or more without adversely affecting acetylene yield or heat requirement or causing substantial carbon black formation in the reactor. Moreover, even though the amount of hydrogen required is thus reduced, the amount of hydrogen formed in the product gas is about the same.

A longitudinal cross-sectional view of a simple reactor employed in the process, and a cross-sectional view of the same unit are shown in the accompanying illustration. The reactor is a vertical cylinder having refractory side walls 10, an upper end enclosure 11 and a conical bottom closure 12. Within the vessel, a transverse refractory partition 15 supported by ring 16 divides the enclosed space into a preheating zone 17 and a reaction zone 18. Electric coil 19 serves as the heating element. All of the preheating tubes 20 are of the same length. Conduits 25 serve for introduction of hydrogen from supply line 28 and manifold 27, and permit hydrogen to be introduced into the reaction zone 18 so as to form a film between its walls and the preheated reactant gas introduced from preheating tubes 20. A quenching medium (water) is sprayed from nozzles 29. Product gas is withdrawn through pipe 31. The reactant gas is introduced through manifold 24 and inlets 23. During passage through tubes 20, it is raised to between 600 and 1500° C.

Best results are obtained with non-aromatic hydrocarbons, particularly those normally liquid and boiling below 400° F. When kerosene is used, the reactant gas may contain as many as 50 moles of oxygen per mole of hydrocarbon. In the case of methane or natural gas, an excess of hydrocarbon is employed (1.33/1 to 3.0/1). The yield of acetylene, based on methane consumed, is about 48% when rate of feed of reactant gas is 62.6 SCFH and the rate of feed of hydrogen is 10.5 SCFH. About one volume of acetylene is formed per volume of hydrogen introduced into the reaction zone. Residence times are 0.005 sec. preheat, and 0.004 sec. reaction.

In patent 2,679,541, there is described a method of employing a moving bed of granular adsorbent and

recirculation of a portion of the gases separated from the acetylene in order to increase actylene yields. Patent 2,679,540, discloses injection of carbon dioxide, ethane, propane or butane as a stabilizing gas in the moving granular adsorbent bed system. The passing of the cooled product gas in indirect heat exchange with a vaporizable liquid is claimed in patent 2,679,543, while patent 2,679,544 discloses production of hydrogen cyanide and acetylene by addition of ammonia.

Chemical Aids Sweetening Action of Naphthas

THE addition of mercapto-alkylbenzamidazoles greatly promotes the sweetening effect of copper naphthenate and similar soaps on hydrocarbon oils, according to The Texas Co. patent 2,674,566. The organic metal salt alone, while possessing good sweetening properties, has the disadvantage of accelerating gum formation. Air blowing has a tendency to increase the rate of sweetening, and traces of alkali metal hydroxide accelerate further the rate of sweetening.

In an example, 10 lbs. per 1000 bbls. of N,N-di-sec-butyl-p-phenylene diamine, 2 lbs. per 1000 bbls. of copper naphthenate and 5 lbs. per 1000 bbl. of 2-mercapto-5-t-amyl benzimidazole in a sour cracked naphtha, gave a product negative to the doctor test after overnight standing.

Patents Issued in July

The following classified listing gives the patent number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U.S. Patent Office for July 6, 13, 20, 27, 1954, Vol. 684, Nos. 1-4.

PROCESSES

Refining

2,683,108 (Universal Oil Products Co.) Removal of Phenolic substances from petroleum fractions with aqueous alkaline earth metal carbohydrate complex.

2,683,683 (Houdry Process Corp.) Removal of heavy metal components deleterious in catalytic cracking feed stocks by contacting with sulfiding agent, and removal of sulfides before contacting with catalyst.

2,683,762 (Standard Oil Co.-Ind.) Xylene separation with liquid HF and TiF_4.

2,683,763 (Standard Oil Co.-Ind.) Refining isomeric dialkyl-benzenes with liquid HF and CbF_5.

2,683,763 (Standard Oil Co.-Ind.) Refining isomeric dialkyl-benzenes with liquid HF and TaF_5.

2,683,972 (Phillips Petroleum Co.) Recovery of natural gas condensate.

2,684,124 (Union Oil Co. of Calif.) Gravity moving bed adsorption process and apparatus.

2,684,270 (Sun Oil Co.) Elevation of granular solids.

2,684,324 (Atlantic Refining Co.) Extraction of petroleum products with solvent containing nitrobenzene-aniline and some CS_2.

2,684,326 (Universal Oil Products Co.) Fractionation control.

2,684,729 (Union Oil Co. of Calif.) Contacting fluid stream with recirculating granular solid adsorbent.

2,684,731 (Standard Oil Development Co.) Adsorption process using recirculating activated carbon.

2,684,762 (Silley and Unthank) Separating water from oil

2,684,837 (Standard Oil Development Co.) Apparatus for operating a vapor-liquid contacting zone.

2,684,838 (Phillips Petroleum Co.) Process for dispensing a soluble fluid beneath the surface of a liquid and valves therefor.

2,684,926 (California Research Corp.) Sodium sulfonates in lead sulfide sweetening process.

2,684,933 (Phillips Petroleum Co.) Auto-distillation for recovery of clean gas oil from residual.

2,684,935 (Shell Development Co.) Distillation to separate isomeric alkyl aromatic hydrocarbons.

2,684,936 (Standard Oil Co.-Ohio) Fractional distillation column.

2,684,949 (Shell Development Co.) Producting dispersions of immiscible liquids or solids in liquid medium.

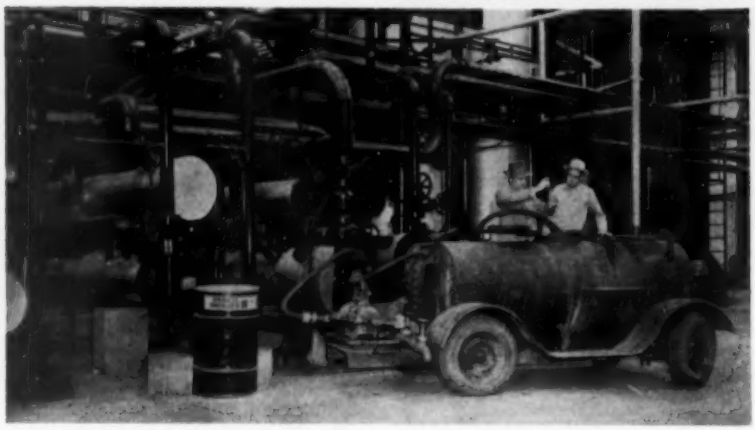
Catalysts

2,683,122 (The Distillers Co. Ltd.) Process of regenerating an oxidation catalyst comprising oxides of phosphorus and molybdenum.

2,684,340 (Davison Chemical Corp.) Sulfate removal from silica-alumina catalyst.

2,684,768 (Socony-Vacuum Oil Co.) Apparatus for handling finely divided contact mass undergoing regeneration.

2,684,951 (Standard Oil Development Co.) Zirconia dehydrogenation catalyst.



How refiner saved $1800 cleaning heat exchangers and condensers

Oakite Compound No. 32 soaks scale off tubes— no pulling of bundles

This Oklahoma refinery used a lot of manpower during turnarounds—pulling exchanger bundles for cleaning, and replacing with spares. Then they called in Oakite.

The Oakite Man knew that in-place cleaning was both practical and fast. So, using a portable tank and pump, he circulated a solution of Oakite Compound No. 32 through two exchangers and two condensers.

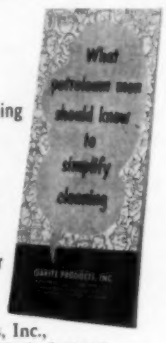
Results: Tubes clean, no attack on metal. Estimated cost of pulling and replacing bundles—$2000. Cost of Oakite materials and method—$160. Saving: $1840.

Proving that—in industrial cleaning it always pays to consult Oakite.

Call your Oakite Technical Service Representative. His experience is yours to draw on. He'll study your cleaning problem, suggest and demonstrate the best material and method. He'll keep checking back to see that you get top quality cleaning at low cost. Call him today!

FREE HANDBOOK— full of facts on

Drum reconditioning
Descaling
Cleaning tanks
Salvage cleaning
Paint stripping
Cleaning tank car interiors



Write Oakite Products, Inc., 50D Rector St., New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
petroleum service division
Technical Service MATERIALS • METHODS • SERVICE Representatives in Principal Cities of U. S. and Canada

Conversions

2,683,109 (Houdry Process Corp.) Methods and apparatus for contacting liquid with granular contact material.
2,683,653 (Phillips Petroleum Co.) Apparatus for dehydrogenating hydrocarbons to produce acetylene.
2,683,657 (Hydrocarbon Research, Inc.) Gasification of solid carbonaceous material.
2,683,685 (Standard Oil Development Co.) Catalytic system employing fluidized catalyst.
2,683,758 (Standard Oil Co.-Ind.) Xylene isomerization utilizing a TiF_6-HF catalyst.
2,684,325 (Universal Oil Products Co.) Improving volatility and antiknock properties of gasoline involving thermal cracking, reforming, polymerization, etc.
2,684,390 (Union Oil Co. of Calif.) Conversion (with moving bed of granular solid) and quenching process and apparatus.
2,684,868 (Union Oil Co. of Calif.) Conveyance of granular solids.
2,684,870 (Union Oil Co. of Calif.) Conveyance of granular solids.
2,684,872 (Union Oil Co. of Calif.) Conveyance of granular solids.
2,684,873 (Union Oil Co. of Calif.) Conveyance of granular solids.
2,684,927 (Socony-Vacuum Oil Co.) Process and apparatus for hydrocarbon conversion using granular contact material.
2,684,928 (Union Oil Co. of Calif.) Solids conveyance of contact material in compact form and apparatus.
2,684,929 (Union Oil Co. of Calif.) Method for handling solids material in conversion of hydrocarbons.
2,684,930 (Union Oil Co. of Calif.) Moving bed solids contact process.
2,684,931 (Union Oil Co. of Calif.) Fluidized solids process for contacting solids and vapors with the conveyance of solids in dense phase suspension.
2,684,932 (Union Oil Co. of Calif.) Apparatus and process for contacting adsorbent solids with fluids through zones of different pressures.

Hydrocarbon Synthesis

2,683,121 (M. W. Kellogg Co.) Preparation of hydrocarbon synthesis gas.
2,683,152 (M. W. Kellogg Co.) Preparation of hydrocarbon synthesis gas.
2,683,158 (Standard Oil Development Co.) Hydrocarbon synthesis process.
2,683,159 (The Texas Co.) Catalytic synthesis of hydrocarbons.
2,683,656 (Phillips Petroleum Co.) Apparatus for controlling synthesis gas reaction.
2,683,726 (M. W. Kellogg Co.) Hydrocarbon synthesis with reduced magnetite catalyst.
2,684,895 (Phillips Petroleum Co.) Synthesis gas manufacture.
2,684,896 (The Texas Co.) Process for production of CO and hydrogen.
2,684,975 (Stanolind Oil & Gas Co.) Carbon dioxide in hydrocarbon synthesis.

PRODUCTS

Chemicals

2,683,076 (Standard Oil Development Co.) Recovery of gases in the sulfochlorination of hydrocarbons.
2,683,078 (M. W. Kellogg Co.) Manufacture of hydrazine, using hydrocarbon and oxide of nitrogen.
2,683,132 (Standard Oil Development Co.) Stabilized relatively nonvolatile organic compositions containing bis (p-hydroxy aryl amides) of polybasic acids.
2,683,135 (Universal Oil Products Co.) Ester and amide derivatives of tetracarboxylic acids.
2,683,138 (Standard Oil Development Co.) Propylene-isoolefin-cyclic olefin tripolymer.
2,683,139 (Standard Oil Development Co.) Hydrocarbon (monoolefin-diolefin) resin recovery process.
2,683,140 (du Pont Co.) Polymerization of ethylenically unsaturated compounds with vanadous catalyst.
2,683,141 (Allied Chemical & Dye Corp.) Continuous production of wax from ethylene and normally liquid organic co-reactant compound.
2,683,151 (Phillips Petroleum Co.) Process for reacting a diolefin and a furfuraldehyde and resulting products.
2,683,162 (Standard Oil Development Co.) Synthetic drying oil modified by after-treatment with polar compounds.
2,683,168 (California Research Corp.) Preparation of organo phosphonyl chlorides.
2,683,169 (California Research Corp.) Preparation of organo phosphonyl chlorides from organo halides.
2,683,174 (Universal Oil Products Co.) Oxidation of isobutylene to produce ketones, aldehydes, and alcohols.
2,683,175 (Phillips Petroleum Co.) Process for production of alpha-hydroxybutyraldehydes.
2,683,177 (Standard Oil Co.-Ind.) Single stage process for alcohols, from CO,H_2 and olefins.
2,683,178 (Phillips Petroleum Co.) Crystal purification process and apparatus.
2,683,688 (Ruhrchemie Akt.) Preparation of alkyl monochlorides by chlorination of hydrocarbons.
2,683,731-2 (National Petro-Chemicals Corp.) Process for absorbing ethylene in sulfuric acid under pressure.
2,683,753 (Imperial Chemical Industries, Ltd.) Hydration of propylene with blue oxide of tungsten catalyst.
2,683,754 (Sun Oil Co.) Alkylating olefin with cycloalkyl fluoride.
2,683,756 (Sun Oil Co.) Reacting a cyclopentane with a cycloolefin.
2,683,757 (Sun Oil Co.) Separating a cyclopentane from a cyclohexane by selective alkylation.
2,683,759 (Standard Oil Co.-Ind.) Ethylbenzene disproportionation.
2,683,760 (Standard Oil Co.-Ind.) Making high purity 1,3,5-ethyl xylene.
2,683,761 (Standard Oil Co.-Ind.) Xylene disproportionation.
2,684,357 (Phillips Petroleum Co.) Stabilized activators and their use in emulsion polymerization.
2,684,382 (California Research Corp.) Separating isophthalic and terephthalic acids from mixtures.
2,684,385 (Standard Oil Development Co.) Continuous aldolization.
2,684,389 (Gulf Research & Development Co.) Alkylation of phenols.
2,684,934 (Stanolind Oil & Gas Co.) Drying methyl ethyl ketone.
2,684,952 (Standard Oil Co.-Ind.) Thiosulfenyl chlorides and bromides and polymers therefrom.
2,684,959 (M. W. Kellogg Co.) Halogenated polymers.
2,684,967 (Union Oil Co. of Calif.) Olefin oxides.
2,684,984 (Shell Development Co.) Cyclic alcohols and ketones.
2,684,985 (Stanolind Oil & Gas Co.) Separation of methyl propyl ketone from valeraldehyde.

TO POSITION DAMPERS, SLIDE VALVES and other control means →

ASKANIA
PNEU-DRAULIC VALVE POSITIONER

The Askania Pneu-Draulic Valve Positioner combines the advantages of both pneumatic and hydraulic control systems. It provides an air signal proportional to valve position, yet has incompressible fluid working at the heart of the unit.

Almost unlimited power can be smoothly and instantly applied with these positioners. For every increment of input signal between 3 and 15 p.s.i., the cylinder position finds a specific position within 1% of full cylinder stroke.

These positioners are rugged enough to withstand almost any abuse, because the signal amplifier has only one moving part—the well protected jet pipe.

Write for bulletin No. 1—86

ASKANIA REGULATOR COMPANY
244 E. Ontario Street, Chicago 11, Illinois
Subsidiary of General Precision Equipment Corp.

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

PALMER
MERCURY ACTUATED
Temperature Indicating
Instruments

RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

WRITE FOR CATALOG INFORMATION

PALMER
THERMOMETERS, INC.
Cincinnati 12 Ohio • MElrose 1500

2.684.986 (Standard Oil Development Co.) OXO process using catalyst paste.
2.684.987 (M. W. Kellogg Co.) Producing halocarbons.

Fuels

2.683.081 (Ethyl Corp.) Stabilized olefin-containing fuel using aryl amino antioxidant.
2.683.082-3 (Ethyl Corp.) N-Aryl-N-(p-hydroxyphenyl) ureas as antioxidants for petroleum hydrocarbon fuels.
2.684.292 (Shell Development Co.) Non-ash distillate fuel oil containing cracked components and moisture made non-clogging with oil-soluble amine.
2.684.293 (Ethyl Corp.) Tetraethyl lead compositions stabilized with disubstituted dihydroxybenzene.
2.684.893 (Standard Oil Co.-Ohio) Aromatic amine gasoline antioxidants.
2.684.894 (Standard Oil Development Co.) Alkali metal chromates as sludge inhibitors for blended fuel oil.

Lubricants

2.683.119 (Standard Oil Development Co.) Compounded lubricant containing ester with sulfur in molecule.
2.683.691 (Shell Development Co.) Extreme pressure lubricants containing P-amino compound.
2.684.334 (Shell Development Co.) Lubricating oil containing reaction product of P_2S_5-terpene and 2,4,6-trialkyl phenol.
2.684.335 (Standard Oil Development Co.) Oxidation inhibitor (reaction product of diphenylamine and trithioacetone).
2.684.336 (Douglas Aircraft Co.) Silicone lubricant containing trialkyl phosphate.
2.684.943 (Continental Oil Co.) Organic composition containing epoxy compound to inhibit H_2S liberation.
2.684.944 (Standard Oil Co.-Ind.) Lithium polyorgano siloxane polymer grease.

Specialties

2.683.120 (Standard Oil Development Co.) Hydraulic transmission fluids containing oil, alkylate, polybutene, barium alkyl phenol sulfide, etc.
2.683.694 (Universal Oil Products Co.) Antioxidant containing butylated anisole and propyl gallate.
2.684.290 (Phillips Petroleum Co.) Pelleting a flocculent powder (carbon black).
2.684.332 (California Research Corp.) Pelletized corrosion inhibitor (sodium arsenite and arsenous oxide).
2.684.333 (California Research Corp.) Pelleted corrosion inhibitor (sodium arsenite and zinc).
2.684.338 (McGowan et al) Emulsifier for paraffin waxes.
2.684.958 (Standard Oil Development Co.) Dispersion process for carbon black.

Miscellaneous

2.683.077 (Standard Oil Development Co.) Roasting sulfide ores using fluidized bed.
2.683.654 (Universal Oil Products Co.) Internally insulated lined reactor.
2.684.076 (Sun Oil Co.) Emergency safety valve.

EQUIPMENT

Processing, general

2.683.178 (Phillips Petroleum Co.) Crystal purification process and apparatus.
2.683.653 (Phillips Petroleum Co.) Apparatus for acetylene generation from hydrocarbons.
2.684,287 (Olin Industries, Inc.) Apparatus for nitrating glycerine and the like.
2.684,288 (La Societe Anonyme "Extraction continue De Smet") Solvent extraction apparatus with automatic controls.
2.684,290 (Phillips Petroleum Co.) Agglomerating process and apparatus.
2.684.729 (Union Oil Co. of Calif.) Adsorption process and apparatus.
2.684.760 (Research Corp.) Electrical precipitator and electrode structure therefore.
2.684,762 (Henry A. J. Silley and George R. Unthank) Apparatus for separating immiscible liquids or liquids and irsoluble solids.
2.684.837 (Standard Oil Development Co.) Apparatus for operating a vapor liquid contracting zone.
2.684.936 (Standard Oil Co.-Ohio) Fractional distillation column.

Catalytic Reactors

2.683.109 (Houdry Process Corp.) Methods and apparatus for contacting liquid with granular contact material.
2.683.654 (Universal Oil Products Co.) Internally insulated and lined reactor.
2.684.124 (Union Oil Co. of Calif.) Gravity moving bed adsorption process and apparatus.
2.684.270 (Sun Oil Co.) Elevation of granular solids.
2.684.390 (Union Oil Co. of Calif.) Conversion and quenching process and apparatus.
2.684.768 (Socony-Vacuum Oil Co.) Apparatus for handling contact mass undergoing regeneration.
2.684.867 (Union Oil Co. of Calif.) Conveyance of granular solids.
2.684.868 (Union Oil Co. of Calif.) Conveyance of granular solids.
2.684.870 (Union Oil Co. of Calif.) Conveyance of granular solids.
2.684.872 (Union Oil Co. of Calif.) Conveyance of granular solids.
2.684.873 (Union Oil Co. of Calif.) Method and apparatus for the conveyance of solids.
2.684.927 (Socony-Vacuum Oil Co.) Process and apparatus for hydrocarbon conversion.
2.684.928 (Union Oil Co. of Calif.) Solids conveyance of contact material in compact form and apparatus.
2.684.929 Union Oil Co. of Calif.) Method for handling solids material in the conversion of hydrocarbons.
2.684.932 (Union Oil Co. of Calif.) Apparatus and process for contacting adsorbent solids with fluids through zones of different pressures.

Instruments

2.682.765 (Union Oil Co. of Calif.) Microflash tester.
2.683.220 (General Aniline and Film Corp.) Spectrograph device.
2.683.224 (Howard W. Cole, Jr.) Flowmeter.
2.683.369 (U.S. Air Corps) Fluid rate of flow indicator.
2,683,371 (Societe de Brevets pour les Applications de l'Electronique) Liquid level indicator.
2.683.372 (Simplex Valve and Meter Co.) Fluid level indicating gage.
2.683.656 (Phillips Petroleum Co.) Process control.
2.683.984 (Dobbie McInnes, Ltd.) Viscosity-measuring device.
2.683.986 (U.S. Navy) Electric gas flowmeter.
2.684.010 (Standard Oil Co.-Ind.) Comparison candle colorimeter.
2.684.078 (Bailey Meter Co.) Fluid flow control system.
2.684.289 (Lloyd V. Guild) Gas analysis pipettes.
2.684.326 (Universal Oil Products Co.) Fractionation control.
2.684.593 (U.S. Army) Pressure gage.
2.684.810 (William C. Bryant) Flowmeter having remote register.
2.684.938 (Ernst Mantzell) Device for measuring pH.

Pumps & Compressors

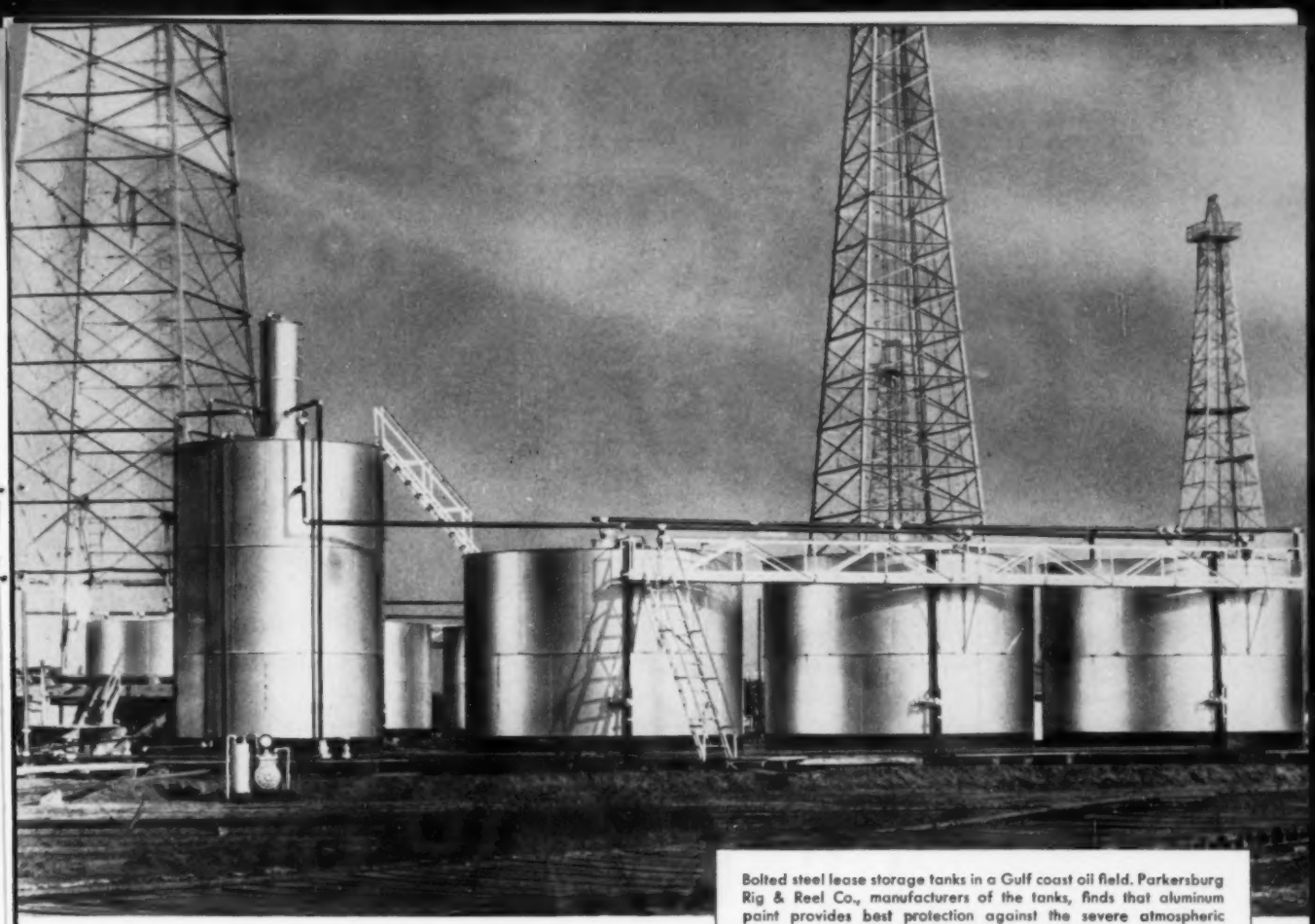
2.683.638 (Pennsylvania Pump & Compressor Co.) Liner for compressors.
2.684.032 (Byron Jackson Co.) Enclosed pump head with air-cooled electric driving motor.
2.684.033 (Barnes Mfg. Co.) Centrifugal pump.
2.684.034 (Roy E. Roth Co.) Liquid cooling structure for pump shafts.
2.684.035 (Philip G. Kemp) Fluid pump.
2.684.037 (Scognamillo Engr. Co.) Rotary pump.
2.684.038 (James P. Johnson) Piston pump.
2,684,195 (Consolidated Vacuum Corp.) Vacuum pump.

Valves & Fittings

2.682.891 (Leslie Co.) Double-seated valve.
2.683.580 (Donald G. Griswold) Pilot controlled multiple diaphragm valve.
2.683.581 (Fabri-Valve Co. of America) Fabricated stainless steel gate valve.
2.683.582 (Phillips Petroleum Co.) Snap action regulator valve.
2.684.076 (Sun Oil Co.) Emergency safety valve.
2.684.079 (Productive Inventions, Inc.) Fluid control valve.
2.684.525 (Richard A. Dominquez) Valve reconditioning jig apparatus.
2.684.596 (Cameron Iron Works, Inc.) Plug valve actuator.
2.684.828 (John M. Roberts) Mixture control valve for regulating proportions and total flow of two or more fluids.
2.684.829 (Hills-McCanna Co.) Valve diaphragm.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25¢ each. Order by patent number direct from The Commissioner of Patents, Washington 25, D. C.



Bolted steel lease storage tanks in a Gulf coast oil field. Parkersburg Rig & Reel Co., manufacturers of the tanks, finds that aluminum paint provides best protection against the severe atmospheric conditions and corrosion problems of this area.

Five reasons why Parkersburg Rig & Reel Company has used aluminum paint since 1925

Since 1925, The Parkersburg Rig & Reel Co., Parkersburg, West Virginia, has painted its rigs, lease tanks and other oil field equipment with aluminum paint. They find that aluminum paint (1) provides better protection against rust, (2) lasts longer and (3) makes a more attractive appearance than other paints.

Used on storage tanks, aluminum paint (4) has a high reflectivity value. The oil in an aluminum-painted tank is cooler, reducing evaporation losses of the lighter fractions of crude.

While Parkersburg equipment is spray-painted at the plant, it gets plenty of rough handling in transportation and erection. The finish is often scarred and soiled. But after erection it can be touched up to look as good as when it left the plant because (5) aluminum paint can be applied with a brush without leaving any "patched up" look. This is almost impossible with other paints.

ALCOA does not make paint, but ALCOA Aluminum Pigments are used in more aluminum paints than any other brand. Special formulas have been developed by your paint manufacturer to solve individual problems. Paints made to these formulas actually cost you less, last longer, give utmost protection against heat, cold, sun, rain, smoke and fumes. Write us today for FREE BOOKLET, *Painting With Aluminum.*

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Paint Service Bureau, Aluminum Company of America
1792-J Alcoa Building, Pittsburgh 19, Pa.

Please send me your FREE BOOKLET, *Painting with Aluminum.* I plan to paint_____

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

When you buy welding elbows . . .

Why take less when you can get more?

. . . (and at the same price)

ADVANTAGES OF MIDWEST "LONG TANGENT" ELBOWS

- ★ They save pipe.
- ★ They often eliminate short nipples and their extra welds.
- ★ They save time and money in lining up and clamping pipe and fitting.
- ★ They make it easier to apply slip-on flanges.
- ★ They remove the circumferential weld from point of maximum stress and can be sleeved.
- ★ THEY COST NO MORE THAN OTHER ELBOWS.

As shown in the illustration above, Midwest "Long Tangent" welding Elbows have straight ends equal to ¼ of the nominal fitting diameter (a 12" elbow has tangents 3" long). For the reasons listed at the left, substantial savings are made on many piping systems by using Midwest "Long Tangent" Elbows. For more information about them, write for Catalog 54.

MIDWEST PIPING COMPANY, INC.

Main Office: 1450 South Second Street, St. Louis 4, Mo.

Plants: St. Louis, Passaic, Los Angeles and Boston

Sales Offices:

New York 7—50 Church St. • Chicago 3—79 West Monroe St.
Los Angeles 33—520 Anderson St. • Houston 2—1213 Capitol Ave.
Tulsa 3—224 Wright Bldg. • Boston 27—426 First St.
Cleveland 14—616 St. Clair Ave.

6722

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

COMMEMORATING 50 YEARS' SERVICE with the Pan American Refining Corp., Llewellyn D. Griffith (right) is presented with congratulatory resolutions passed by the board of directors. With Mr. Griffith are members of the corporation's board, left to right, Harold R. Snow, vice-president; D. J. Smith, chairman; and L. W. Moore, president. Mr. Griffith has been night superintendent of the refinery at Texas City, Tex., since 1934. He will retire from the company on his 65th birthday, January 24, 1955

Dwight S. Simmons is the new manager of the Imperial Oil Ltd.'s manufacturing department, succeeding **G. L. MacPherson,** who was elected to the board of directors last spring.

Mr. Simmons

Mr. Simmons will be replaced as assistant general manager of manufacturing in charge of refinery planning and engineering by **J. A. Cogan.**

Mr. Simmons, a graduate of Queen's University, joined Imperial Oil in 1932. During World War II he was on loan to the St. Clair Processing Corp. In 1950, once again with Imperial, he became manager of the engineering and development division of the manufacturing department. He served for a year as general superintendent of the Montreal East refinery, and for the past two years has been an assistant general manager of the department.

For the past seven years Mr. Cogan has been manager of the coordination and economics department of Standard Oil Co. (N. J.). He is a graduate of Colorado College and Massachusetts Institute of Technology. He joined Jersey Standard in 1934, after spending two years with the Standard Oil Co. of Louisiana.

Hamilton P. Caldwell, Jr., formerly assistant superintendent of Socony-Vacuum Oil Co.'s East Providence, R. I., refinery, is now manager of the refinery, replacing **Henry A. Rickett,** who is serving as a consultant at the plant until his retirement at the end of the year.

Mr. Caldwell joined General Petroleum Corp., Socony-Vacuum's west coast affiliate, in 1934, following his graduation from Purdue University. After 1936 he was in the company's research and development department at Paulsboro, N. J., where he became supervisor of the refining section of the process division. He became assistant superintendent at East Providence in 1953.

Mr. Rickett has given more than 40 year's service to the company. A graduate of Worcester Polytechnic Institute, his first job in 1914, was as a research chemist with the old Standard Oil Co. of New York. In 1918 he became assistant superintendent of the grease and compounding works in Brooklyn, N. Y., and in 1919 was transferred to the East Providence refinery and placed in charge of the laboratory. He became assistant superintendent of the refinery in 1932 and superintendent in 1947.

Frank V. Williams has been promoted from assistant superintendent to superintendent of the Olean, N. Y., refinery, assuming the post formerly held by **Walter E. Wanner,** who has retired after 38 years at the refinery.

Mr. Williams is a 1933 graduate of the Drexel Institute of Technology, where he took his B.S. in mechanical engineering. After working on a number of processing units at the Paulsboro, N. J., refinery during the years 1935-40, he was made the night superintendent there. He was transferred to Olean as assistant superintendent in 1945.

Mr. Wanner was graduated from Cornell University in 1913 and joined the Olean refinery as assistant to the chief engineer in 1916. He continued in this post until 1929, when he became chief engineer, A year later he was appointed assistant superintendent of the refinery, and in 1945 superintendent.

Dr. G. S. Schaffel has been appointed manager of research for Brea Chemicals, Inc., a subsidiary of the Union Oil Co. of California. He was formerly with General Tire and Rubber Co., where he was active in chemical research and production work.

Dr. Schaffel

Dr. Schaffel received his Ph.D. from the Carnegie Institute of Technology in 1942 and accepted a post-doctorate fellowship in fundamental research at Westinghouse Research Laboratories. There he remained until 1946, when he accepted a position with General Tire and Rubber Co.

L. R. Goldsmith has been promoted to manager of manufacturing of Shell Oil Co., replacing **A. H. Calderwood,** who will shortly undertake a European assignment for the company and retire at the end of the year. Mr. Goldsmith's post of manager of the technological department has been assumed by **J. E. Marsland,** who was moved up from assistant manager.

Mr. Goldsmith received his B.S. degree in petroleum engineering from the University of California at Berkeley and joined Shell in 1932 at Martinez, Calif. He was with PAW at Washington for two years during World War II, and in 1946 became superintendent of the Shell refinery at Wilmington, Calif. Mr. Goldsmith was appointed to the staff of the economic development department in New York in 1949 and was given the managership of the technological department in 1951.

Mr. Marsland holds a B.S. degree in chemistry from the California Institute of Technology and an M.S. from the Massachusetts Institute of

For Tops in Pipe Wrench Performance...it's the Genuine

RIDGID

If this Housing ever Breaks or Distorts we will replace it Free
RIDGID
HEAVY
Every RIDGID Wrench Work-TESTED at the factory

...with the guaranteed trouble-free housing!

Only the RIDGID has a world-wide rep as the finest pipe wrench made. Only RIDGID has earned and maintains this rep by building toughness and smart performance into these overwhelmingly popular wrenches, checking them part by part and *hard work testing every last one* before shipment. When you buy a RIDGID, you know the housing won't break, the jaws won't slip or lock, the adjusting nut spins easily to all sizes, 6" to 60". Always most for your money—ask your Supply House.

Have you tried the new RIDGID Spud Wrench?

Deep narrow jaws for close work—break-proof housing — famous RIDGID jaw suspension — comfort-grip I-beam handle. Ask your Supply House.

THE RIDGE TOOL COMPANY, ELYRIA, OHIO, U. S. A.

RIDGID

Work-Saver Pipe Tools

Technology. His first post with Shell was at Martinez in 1933. He became chief technologist at Wilmington in 1945 and was transferred to New York in 1948 as senior technologist. His appointment as assistant manager of the technological department came in 1949.

Paul E. Hurley has been appointed manager of Shell Oil Co.'s Houston, Texas, refinery, replacing **M. P. L. Love,** soon to begin a special assignment for the company abroad.

Mr. Hurley transfers to his new assignment from the Norco, La., refinery, where he was manager after 1945. His employment with the company extends over 34 years, from the time he started work as a gager at the Wood River, Ill., refinery in 1920. After a series of promotions he became superintendent at Norco in 1938, then acting superintendent of the Houston refinery from 1942 until the time he returned to Norco as manager.

Roy W. Faulk, superintendent at Norco for the last year and a half, has taken the manager's post vacated by Mr. Hurley. Mr. Faulk was manager of the manufacturing department of Shell Oil Co. of Canada before he became superintendent at Norco.

Morris R. Morrow has been promoted to research specialist in Humble Oil & Refining Co.'s research and development division, Baytown, Texas. Mr. Morrow received his B.S. and M.S. degrees in chemical engineering from the University of Texas in 1939 and 1940. He joined Humble at that time and has worked largely with aviation and motor fuels and certain specialty solvents and naphthas.

J. D. Booker has been given the title of technical specialist in the technical service division at Baytown. Mr. Booker took his B.S. degree in chemical engineering at the University of Texas in 1941 and joined Humble the same year. As a technical specialist his work will be primarily in the fields of process design and follow-up analy sis of new installations in the refinery.

Gerald Fisher has been named pollution control coordinator for the General Petroleum Corp. He has been with the company over 30 years and since 1944 as manager of the lubricants and process products department. Mr. Fisher is a graduate of the University of Oklahoma.

G. M. Cook has been appointed assistant to the president of Oronite Chemical Co., a marketing subsidiary

of Standard Oil Co. of California. Mr. Cook came to Oronite from the California Research Corp., where he was senior research chemist.

T. H. Paulsen, formerly assistant to the vice-president in charge of manufacturing and cost estimation, Sinclair Chemicals, Inc., has been promoted to chief process engineer of the company.

A 1947 graduate of Michigan State College, he was employed soon afterward in the process design division of Sinclair Research Laboratories, Chicago, Ill. In 1951 he became assistant to the vice-president of the laboratories, in New York. He joined Sinclair Chemicals, Inc., in 1953.

E. Clarence Oden has resigned as chief process engineer of the Cities Service Ref. ing Corp. and opened a consulting office in Lake Charles, La.

Mr. Oden holds a B.S. from the University of Alabama and a Master's from the Polytechnic Institute of Brooklyn. He has done graduate work at Cornell and the University of Michigan. Before joining Cities Service he worked with United Color & Pigment Co., U. S. Rubber Co., and Mathieson's Magnesium Plant, in each case as a chemical engineer.

He began with Cities Service in 1944, first as a senior process engineer, then assistant chief process engineer. From 1948 until his retirement he was the company's chief process engineer.

H. F. Tomfohrde, Jr., has been promoted by Tide Water Associated Oil Co. to secretary of the eastern division operating committee and assistant to the vice-president and chairman of the committee.

He began with the company in 1929 as a development engineer at the Bayonne, N. J., refinery, transferred in 1936 to the New York office and the manufacturing department, and was named assistant to the vice-president of the department in 1950, the post he held at the time of his latest assignment.

Sherman S. Shaffer, staff associate in the refining department of Humble Oil & Refining Co., Baytown, Texas, has been awarded an honorary doctorate of science degree by Cornell College, Iowa, where he received his B.S. and M.S. degrees in 1922 and 1923. He holds another doctorate, from the University of California, which he earned in 1926 for his work in physical chemistry.

Dr. Shaffer has been with Humble since 1926 and has worked as foreman of what was once called the development department, and as head of the experimental and testing division. The latter post he held until 1952, when he took up his present assignment in the technical and research division of the refining department.

An Award of Merit for his many contributions to the American Society for Testing Materials has been given to **Stewart S. Kurtz, Jr.,** manager of the analytical division of the research and development department, Sun Oil Co., Philadelphia.

Mr. Kurtz

Since 1942 he has engaged in technical work for ASTM as a member of a number of its committees: D-1 (paint and varnish), D-2 (petroleum products), D-11 (synthetic rubber), and D-16 (aromatic solvents).

From 1942 until February of 1954 Mr. Kurtz served as chairman of the Committee D-2 research division IV. This body he organized under conditions of wartime urgency to develop a standard test method to determine the aromatic content of military fuels, when it was discovered that higher aromatic fuels could not be used successfully in planes equipped with self-sealing gasoline tanks. Within six months the problem was solved, the solution owing much to the work of Mr. Kurtz's group.

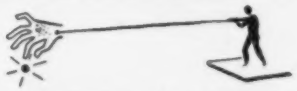
Mr. Kurz was graduated from Harvard with an A.B. degree in 1921 and an M.A. in 1922.

He worked as a research chemist with Goodyear Tire and Rubber Co. from 1924 to 1928, and from the latter year until 1935 held a similar position with the Atlantic Refining Co. In 1935 he joined Sun Oil Co., first as manager of the chemical section of the newly organized development division at Marcus Hook, then, in 1942, as manager of Sun's Norwood laboratory. He assumed his present position in 1953.

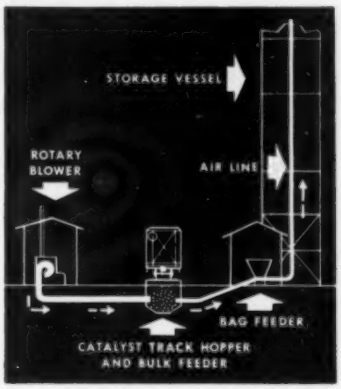
Kenneth G. Mackenzie has been elected an honorary member of the American Society for Testing Materials. Mr. Mackenzie retired from The Texas Co. March 1 after 43 years with the company.

He has been a member of ASTM for more than 42 years, serving during that time as its president and in re-

what's NEW in Engineering



A new electronically-controlled manipulator has been developed by engineers at Argonne National Laboratory to permit scientists to handle "hot" radioactive materials at a distance of several hundred feet or from behind sealed barriers. The new unit, which uses electrical signals, reproduces the same seven basic motions involved in grasping, lifting, moving and turning objects.



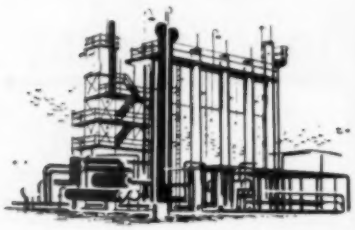
Replacing a conventional mechanical batch system of handling catalyst, Kaiser Engineers developed a continuous air stream bulk handling method. Operating costs were reduced by this unique system which moves catalyst at 7½ tons per hour with an attrition loss of less than the 2% maximum guaranteed.

Modern Physics for the Engineer, edited by Louis N. Ridenour, is a collection of lectures given by a group of distinguished physicists and others at the University of California, Los Angeles. The aim of the book is to give engineers a brief account of some of the most interesting developments in this fundamental physical science. Published by McGraw-Hill.

Kaiser Engineers has approximately 600 professional engineers, technical experts and staff ready to tackle your problem in design, engineering or construction. Call or write: Kaiser Engineers Division of Henry J. Kaiser Company, Kaiser Building, Oakland 12, California.

PROBLEM

To produce hydrogen essentially free of carbon monoxide which has a deleterious effect on product quality and plant capacity for edible oil producers.



SOLUTION

GIRDLER developed a highly active durable catalyst, G-12, for removal of carbon monoxide from the hydrogen. Cost of hydrogen production was reduced and carbon monoxide content was cut 95% resulting in:

Hydrogen with less than 5ppm of carbon monoxide

Take advantage of the experience of Girdler in solving *your* catalyst problems!

FOR

Catalysts

WRITE...

The

GIRDLER

Company

A DIVISION OF
NATIONAL CYLINDER GAS COMPANY
Gas Processes Division
LOUISVILLE 1, KENTUCKY
NEW YORK • TULSA • SAN FRANCISCO

sponsible positions on many committees.

Following his retirement, Mr. Mackenzie opened a consulting service, which he operates from offices in Westport, Conn., and Chicago.

Dr. Thomas W. Mastin has been promoted from assistant director to director of research and development of the Lubrizol Corp., Cleveland.

Dr. Mastin

He was graduated from Wabash College, Indiana, in 1938 with a B.S. degree in chemistry. Later he received both his M.A. and Ph.D. degrees in chemistry from the University of Illinois. He joined the Lubrizol Corp. in 1942 as a research chemist and was promoted the following year to director of the chemical research laboratory.

Dr. Mastin has been active in the American Chemical Society for 20 years, and was chairman of that group's petroleum section for several years.

An advisory board to recommend recipients of grants for research in the petroleum field has been appointed by the American Chemical Society with **Dr. Cary R. Wagner,** a consultant with Phillips Petroleum Co., as chairman. The grants being distributed are part of the petroleum research fund set up by the society some years ago.

Requests for grants-in-aid should be in the form of a written proposal describing the work to be done, the qualifications of the investigator for such research, the facilities available, the extent to which teaching and training of students may be advanced by the study, and the amount of money desired.

All proposals should be sent in triplicate to the board at the American Chemical Society, 1155 Sixteenth St., N.W., Washington 6, D.C. The board's policy stipulates further that the work must be done in a nonprofit institution, either in the U. S. or abroad, and all patents resulting from such work must be immediately dedicated to the public on a royalty-free basis.

Dr. R. K. Stratford, scientific advisor to Imperial Oil Ltd., has been awarded the 1954 medal of the Chemical Institute of Canada. The medal is given annually for outstanding contribution to Canadian chemistry and chemical engineering.

Dr. Stratford was active in research that resulted in the use of phenol as a selective solvent for extracting lubricating oil. He was also a pioneer in research on suspensoid catalytic cracking, and a modification of his process produced the butylenes needed for the production of synthetic rubber at the Sarnia, Ontario, refinery. He has also made significant contributions to research on asphalts for road construction, greases, and other processes of vital importance to the petroleum industry.

Dr. Stratford is connected with the Sarnia refinery and is president of the Research Council of Ontario. In addition, he is Canada's representative on the permanent council of the World Petroleum Congress.

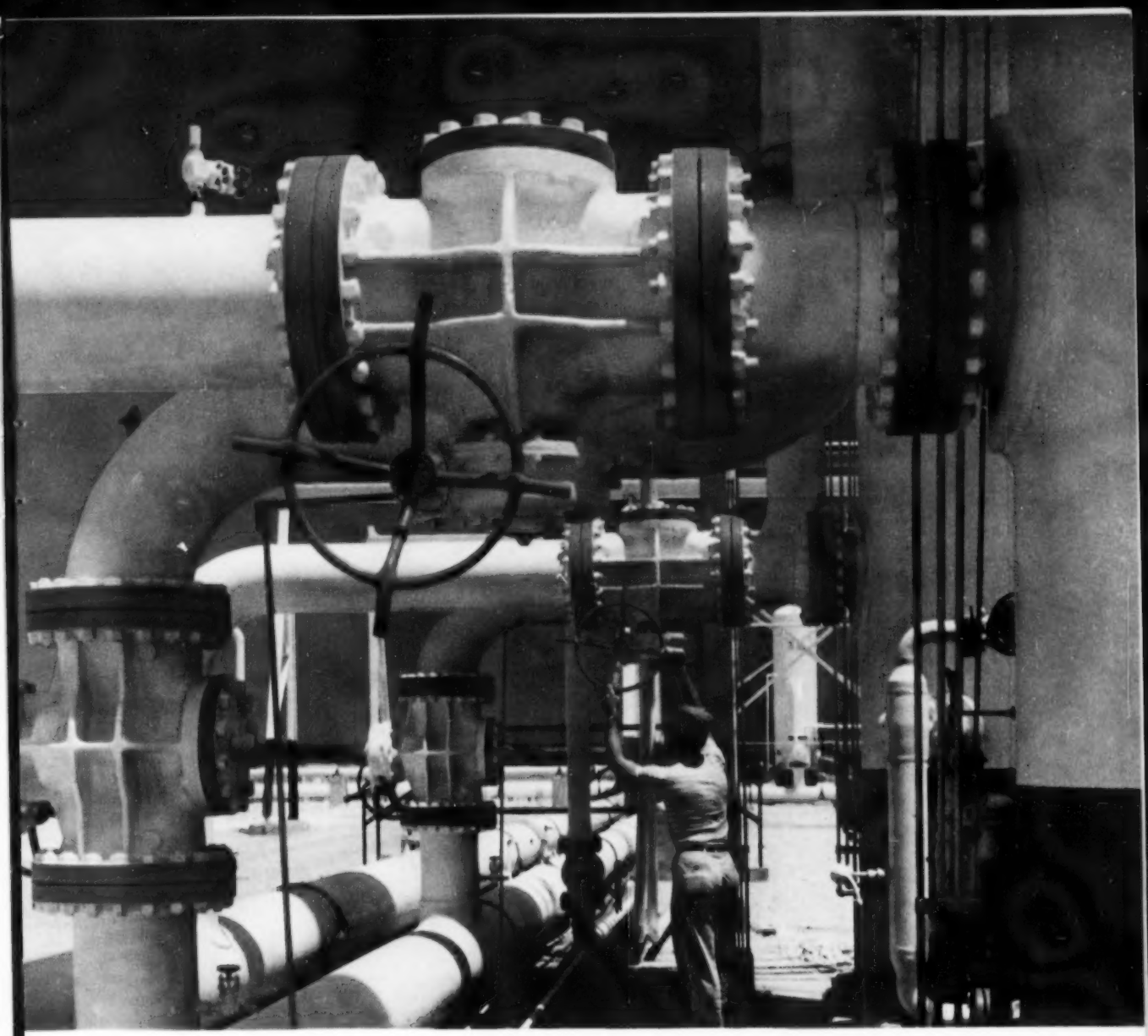
A. C. Lyles, senior gas engineer, General Petroleum Corp., is the new president of the California Natural Gasoline Association. He officially took office at the annual meeting of the association held in Los Angeles.

Mr. Lyles served as vice-president of the group since 1953 and has been a member beginning in 1927. He was a member of the editorial committee and of the technical committee, the latter for 12 years, two of them as the committee's chairman. He was on the board of directors for five years prior to becoming vice-president. Mr. Lyles is a graduate of Colorado College and Cornell University.

Charles H. Goss, manager of the Franklin Refinery, a division of L. Sonneborn Sons, Inc., will retire at the end of this year. He will be replaced on February 1, 1955, by **Leslie C. Borell,** who has been working as the refinery's technical director.

Mr. Goss started at the refinery as assistant superintendent of the Foco Oil Co. and remained with it after L. Sonneborn Sons took over in 1924. Since that time he has served successively as superintendent and manager. After his retirement he will continue as an advisor to management at the refinery.

Mr. Borell is a graduate of Grove City College, where he was given a B.S. in chemical engineering, and the University of Pittsburgh, which awarded him an M.S. degree. He started with L. Sonneborn Sons in 1932, his first assignment being at the Daugherty refinery, Petrolia, Pa. Later the same year he transferred to the Franklin refinery, where he served first as a chemist and more recently as technical director.



OPEN....CLOSE....EASY....QUICK....TIGHT

Certainly . . . no question the valve will operate when it's needed if it's a Rockwell-Nordstrom. It isn't necessary to experiment with valves—Rockwell has done the research for you. The originator of lubricant-sealed valves, with more valves in more different services than any manufacturer, Rockwell can fit the proper valves and lubricants to your application.

There is no substitute for Rockwell-Nordstrom experience—use it to save money on valves. *Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.*

THREE WAYS THE NORDSTROM LUBRICANT WORKS

Lubricant surrounds each valve port with a vapor tight pressurized seal. **Nordstrom valves stay tight.**

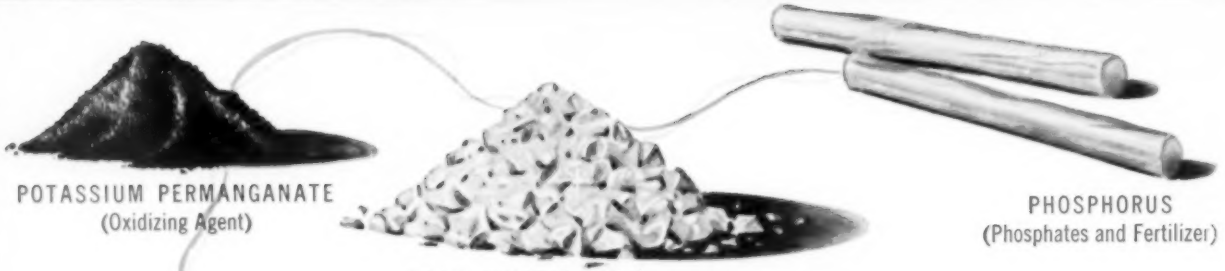
Lubricant acts as hydraulic jack—a fast quarter-turn to open or close. **Nordstrom valves operate quickly.**

Lubricant coats the plug for sliding action—no wear-producing wedging. **Nordstrom valves operate easily.**

Rockwell

NORDSTROM VALVES

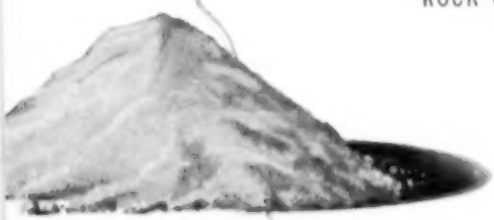
Lubricant Sealed for Positive Shut Off



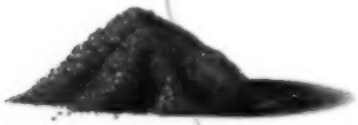
POTASSIUM PERMANGANATE
(Oxidizing Agent)

ROCK CRYSTAL SALT
(Brine)

PHOSPHORUS
(Phosphates and Fertilizer)



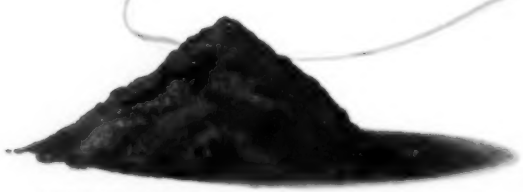
CLAY SLIP
(Ceramics)



POTASSIUM DICHROMATE
(Oxidizing Agent)

BAUXITE
(Aluminum)

SULPHUR



FERRIC OXIDE
(Paints)

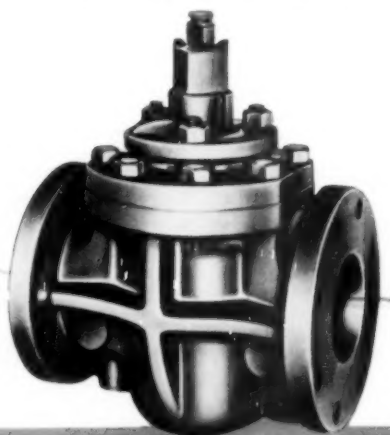
HOW TO END SLURRY WORRY

Slurries and entrained solids eat the heart right out of many types of valves—and incidentally eat up process industry profits at the same time.

The point is that all solids are essentially abrasive, gritty, erosive. They tend to pit ordinary valve seats, or channel leakage paths, and replacement costs mount.

But not necessarily. Rockwell-Nordstrom valves have been proven to outlast other valves in many difficult services, like those shown here.

The reason is this: there's no exposed seat to wear away; instead there's a pressure seal of lubricant, and the essential points of closure are out of the path of flow. There are no valve body pockets to catch sediment either—just smooth, straight-through flow. And for almost any service, there's a correct and tested genuine Rockwell-Nordstrom lubricant. Get the facts from *Rockwell Manufacturing Company, Pittsburgh 8, Pa.*



Nordstrom Valves
Another Quality ROCKWELL Product

GAS BURNERS FOR EIGHT RADIANT HEAT furnaces at Gulf Oil's Port Arthur, Texas, ethylene plant are shown here being loaded at the Selas Corp. of America's factory in Philadelphia, where they were manufactured. The shipment of 800 burners is said to be the largest of its kind ever made. The Gulf Oil installation will produce an estimated seven billion cubic feet of ethylene annually, which will make it the world's largest ethylene plant

CB&I to Make Clad Steel

A new, erosion-resistant clad steel will be turned out by Chicago Bridge and Iron Co. in facilities now under construction at its Birmingham, Ala., plant. To be known as "Hortonclad," the material will be composed of steel and an undisclosed alloy, which will be combined by a process developed in the company's laboratories.

The building currently being constructed is 135x350 ft. and will house equipment capable of handling plates 120 inches wide by 30 feet long. The company's expansion program has added, in recent months, a 116x400-ft. extension to the structural shop, a new 100x280-ft. erection warehouse, and a 50x52-ft. shop office and medical department.

Three New Kellogg VPs

M. Joseph Carnesale has been elected vice-president of the Canadian Kellogg Co., Ltd., Toronto, a subsidiary of the M. W. Kellogg Co. He is responsible in his new post for the sales of petrochemical plants and oil refineries. A graduate of New York University in chemical engineering, Mr. Carnesale was associated with the petroleum refining industry for 13 years before joining M. W. Kellogg Co. in 1944.

Another newly elected vice-president of the Canadian company is Donald W. Champlin, who is also vice-president of the M. W. Kellogg Co.

James A. Petrie, Jr., manager of the Kellogg International Corp.'s London office for three years, has been elected a vice-president and re-elected a director of the corporation. The corporation is an M. W. Kellogg Co. subsidiary. Mr. Petrie joined the parent company in 1936. Frank E. Johnson, Jr., has succeeded Mr. Petrie as manager of the London office.

Girdler Adds to Catalyst Plant

Late 1954 or early 1955 will see the completion of an addition to the Girdler Co.'s Louisville, Ky., catalyst plant and the consolidation of the company's catalyst manufacturing activities at this location. The additional unit is adjacent to the activated carbon facility the company constructed in 1952.

The Girdler Co. produces catalysts for hydrocarbon reforming, carbon monoxide conversion, hydrogenation, desulfurization and oxygen removal, in addition to catalysts for special processes made at the customers specifications. The company is a division of the National Cylinder Gas Co., of Chicago.

C-B Promotes Three Engineers

W. R. Crooks has been promoted to chief engineer of the development division, one of the Cooper-Bessemer Corp.'s three new primary engineering divisions formed in a recent company reorganization. Mr. Crooks held various engineering positions with Fairbanks-Morse Co. from 1923 until he joined Cooper-Bessemer in 1936. He is a graduate of the University of Missouri.

Chief engineer of the product division, the second new unit, is Dennis L. Gallogly, who began with the company 25 years ago. He was appointed supervisor of the Grove City, Pa., test floor in 1934. In 1940 he was made service manager for the company. Mr. Gallogly is a graduate of Ohio State University.

The technical division has T. O. Kuivinen as chief engineer. He was awarded a bachelor of mechanical engineering degree from Ohio State University in 1929, receiving his M.E. in 1937. He started with Cooper-Bessemer in 1929 and has held various engineering positions with the company.

The new organization plan is headed by R. L. Boyer, vice-president and chief engineer of the company. Coordination of the efforts of the three divisions is the job of E. Frederick, executive engineer.

Paint Consultants Organized

Protective Coating Engineering and Inspection Service, a newly organized firm, has opened headquarters in Houston, Texas, at 4101 San Jacinto St., phone number LYnchburg 1974.

Head of the company is Warren D. Palmer, for the past 12 years associated with Monsanto Chemical Co. at Texas City, and the last six years on specific duties as inspector and protective coating engineer in the corrosion and engineering section.

The company will offer complete engineering and technical consulting for problems in protective coatings. It will not sell coatings nor provide painting contract work. The region to be covered will comprise the entire Gulf Coast from New Orleans, La., to Brownsville, Texas.

Rucker Starts Building Program

An expansion program involving the construction of a new warehouse and plant building was initiated recently by the Rucker Co., manufacturer and distributor of the Rucker automatic drum-filler used in the petroleum industry. The firm also designs, engineers and

ORONITE
LUBE OIL
ADDITIVES

Low temperature performance evaluation seen from inside new all-weather chassis Dynamometer test cell.

will help you stay ahead of competition

This new chassis Dynamometer is typical of the advanced research we employ to develop superior Oronite additives. The research and testing facilities behind Oronite additives are the most advanced in the nation.

With years-ahead research, it is possible that Oronite additives could provide your finished oil with the competitive advantages you need to win and hold a market. Oronite will tailor-make additives to your base oils — meeting your price and performance specifications.

Why not see what Oronite additives can offer you? Phone or write the Oronite office nearest you. An additive specialist will contact you on request.

With Oronite Additives you can formulate oils to meet the new A.P.I. Service Classifications and can meet specifications for 2-104-B, MIL-O-2104, Supplement I and Series 2 oils.

OTHER ORONITE PRODUCTS

Gas Odorants
Polybutenes
Phenol
Dispersant FO
(Furnace Oil Inhibitor)
Wetting Agents

2892

ORONITE CHEMICAL COMPANY

ORONITE CHEMICAL COMPANY
200 Bush Street, San Francisco 20, California
30 Rockefeller Plaza, New York 20, New York
20 North Wacker Drive, Chicago 6, Illinois
714 W. Olympic Blvd., Los Angeles 15, California
Mercantile Securities Building, Dallas 1, Texas

distributes pneumatic and fluid power systems for industrial users in six western states.

An expenditure of $200,000 is expected to go into the erection of the two-story, modern concrete structure, which will contain 21,000 sq. ft. when it reaches completion early in November. The company will be able to consolidate under one roof operations that are presently carried out in two separate buildings.

Finn Joins Wyandotte Chemicals

Paul A. Finn recently joined the industrial sales and service staff of Wyandotte Chemicals, a firm that makes specialized cleaners for the petroleum and metal processing industries. For seven years Mr. Finn was in charge of a chemical laboratory that served these industries. Subsequently he worked as southwest regional sales manager for a chemical research firm associated with the industrial cleaning industry.

Mr. Finn has established his headquarters in the Wyandotte Houston office and will specialize in maintenance service for the petroleum industry.

He is a member of the American Petroleum Institute, Society of Automotive Engineers, American Society of Mechanical Engineers, and the American Electroplaters' Society.

Models Firm Opens Affiliate

Industrial Models, Inc. (Del.), constructors of detailed miniatures of industrial facilities, has opened an European affiliate in The Hague called Industrial Models, N.V. (Holland). The firm will produce models of oil refineries and chemical plants for the European and American markets. Managing director is David A. Parvis.

Rockwell Engineers Get Key Posts

Howard J. Evans, until recently chief engineer of Rockwell Manufacturing Co.'s Equitable Meter Division, and H. A. Altorfer, who held the same post in the company's Nordstrom Valve Division, have been promoted to key jobs in two new central research and development departments created recently by Rockwell.

Mr. Evans has been made chief engineer and manager of the central gas products' research and development department, and Mr. Altorfer has become chief engineer and manager of the central valve research and development department. Both men have their headquarters in Pittsburgh, where Rockwell has its main office.

Mr. Evans joined Rockwell in 1935, after receiving his master's degree from the University of Oklahoma in 1934. His first position was as an engineer in the Pittsburgh plant. In 1948 he was transferred to the DuBois, Pa., plant for three years as chief engineer, returning to Pittsburgh in the same capacity in 1951.

Mr. Altorfer, who graduated with highest honors from Winterthur Institute of Technology in Switzerland, spent two years designing machine tools for the Escher-Wyss Co. of Zurich, Switzerland.

From 1933 to 1941 he was with the Terry Steam Turbine Co., Hartford, Conn., and from 1941 to 1949 he was gas turbine design supervisor for Allis Chalmers Manufacturing Co. Rockwell employed him in 1949 as chief engineer of Nordstrom Valve Div.

C&C Markets New Chemicals

Two new chemicals, N-butyl and N-2-ethylhexyl aniline, are now being distributed in drum quantities by Carbide and Carbon Chemicals, a division of Union Carbide and Carbon Corp. The new products are said to have several advantages over aniline and the lower N-alkyl anilines, such as lower water solubilities, higher boiling points, lower vapor pressures, lower toxicities, and higher solubilities in oil or hydrocarbons.

Among the applications predicted for the compounds are with processes requiring N-alkyl anilines in the production of dyes and pigments, surface-active agents, flotation reagents, explosives and propellent stabilizers, gum and corrosion inhibitors, oil and gasoline additives, rubber chemicals, resins and plastics, and varnishes and coatings.

An introductory price for drum quantities of these chemicals has been set at 75¢ per pound, f.o.b. South Charleston, W. Va.

Personnel Changes

Consolidated Engineering Corp.—James R. Bradburn to president of the ElectroData Corp., Consolidated affiliate, replacing Philip S. Fogg, who remains chairman of the board; Joseph E. Jenkins to manager of the Washington district office of CEC Instruments, Inc., a Consolidated subsidiary.

Davison Chemical Co.—Page Edmunds to general sales manager of the petroleum catalyst department, succeeding Charles W. Saacke, who has resigned to become president of Commonwealth Oil Refining Co. of Puerto Rico.

NOW! SHAFT DRIVE POWER in LIGHT hauling!

TOTAL OPERATING COST ¾¢ PER MILE

• EXTRA POWER
• EXTRA CAPACITY
• EXTRA ECONOMY

Slash inner plant handling and delivery costs as have hundreds of other plants. Put Cushman 780 TRUCKSTERS on your jobs—NEW this year with SHAFT DRIVE. Complete with 3 speeds forward, one reverse. Get the EXTRA power advantages of big vehicle shaft drive—plus quick, easy handling AND low operating cost—less than a penny a mile. With capacity up to 500 pounds, TRUCKSTER can speed up hundreds of handling jobs for you!

Cushman 780 SHAFT DRIVE TRUCKSTER

● Write for FREE illustrated booklet
● See Your Nearest Cushman Dealer for FREE demonstration

SOLD and SERVICED NATIONALLY

CUSHMAN MOTOR WORKS, INC. 966 No. 21st St. Lincoln, Nebraska

REED TRADEMARK Announces . . . . . a revolutionary New HINGED PIPE CUTTER

You can cut off 8" pipe, in less than 5 minutes

send for free literature on these amazing cutters for standard steel and cast iron pipe from 2½" to 12".

MAIL THIS COUPON TODAY

REED MANUFACTURING CO.
ERIE, PA.

Without obligation, please send me descriptive literature on your new hinged pipe cutters.

Name _____
Company _____
Street _____
City _____ State _____

YOU CAN STILL GET YOUR COPIES OF THESE POPULAR REPRINTS

"REFINERY INSTRUMENTS—WHAT MAKES THEM TICK?"

A series of 8 articles by Cornelius E. Shannahan, instrument engineer with M. W. Kellogg Co., dealing with the four basic refinery instruments (pressure, temperature, flow, level), plus sections on controllers, control valves and pneumatic transmission—40 pages, 8¼ x 11¼, paper bound (1951-2) **$1.00**

"VAPORIZATION EQUILIBRIUM CONSTANTS AND ACTIVITY COEFFICIENT CHARTS"

41 working-scale charts (21 equilibrium constant charts for the hydrocarbons from methane to 700°F. boiling point, and 20 activity coefficient charts), plus a description of how to use them—48 pages, 8½ x 11, paper bound (1949) **$1.50**

"SHORT-CUT PROCESS DESIGN METHODS FOR HIGHER PROPANE RECOVERY"

A series of 8 articles by Alan S. Glendening and Charles F. Sanderson, covering rich oil de-ethanizers, absorber refrigeration, multi-stage distillation and gas fractionation—40 pages, 8¼ x 11¼, paper bound (1949) **$1.00**

SEND YOUR ORDERS TO READER'S SERVICE DEPARTMENT IN CARE OF:

All prices are postpaid. New York City residents add 3% City Sales Tax.

PETROLEUM PROCESSING

330 West 42nd Street, New York 36, N. Y.

CLASSIFIED ADVERTISING

CHIEF ENGINEER and MAINTENANCE SUPERINTENDENT

Resourceful man wanted wth at least seven (7) years experience in petroleum refinery maintenance and engineering department, two (2) years of which should be in areas with fairly severe winter conditions. Supervisory experience necessary as well as knowledge of catalytic cracking and coking plant operations. M. E. Degree or equivalent required. Salary commensurate with ability. Reply by letter giving complete resume of personal and work history.

GREAT NORTHERN OIL COMPANY

P. O. Box 3596 St. Paul, Minn.

STANDARDS ENGINEER

Major Oil Company has excellent opportunity for a graduate engineer to head a new section of the Engineering and Construction Department's Engineering Research Division, engaged in developing and maintaining material and equipment standards and specifications for company-wide application. If you have had extensive experience in standardization work in petroleum or other integrated process industry, and are now earning about $10,000, send resume in confidence to Mr. H. M. Overley, P. O. Box 7258, Philadelphia 1, Pa.

An Investment!

Productive advertising is an INVESTMENT rather than an EXPENDITURE. "Classified" advertisers almost invariably report prompt and satisfactory results.

BE CONVINCED—send us your advertisement. TODAY.

Address Classified Advertising Division

PETROLEUM PROCESSING

330 W 42nd St., New York 36, N. Y.

Suppliers

Roots-Connersville Blower Division—Franklin P. Bogardus, from district manager of the firm's Cleveland, Ohio, office to district manager at the Chicago office; Richard L. Tannehill to the Cleveland office in replacement of Mr. Bogardus. The company is a division of Dresser Industries, Inc.

Orbit Valve Co.—Ralph G. Soape, sales representative, from Corpus Christi, Texas, office to Houston office; Howard M. Johnson replaces Mr. Soape at Corpus Christi; James M. Pitts to the North Dakota and Montana territory as sales representative.

Gates Engineering Co.—Joseph M. Hoopes to sales manager of the district which includes Delaware, Maryland, New Jersey, New York, and Pennsylvania; Edward Wroth to sales manager of Ohio, Indiana, Kentucky, and Michigan territory.

Blaw - Knox Co. — Alexander E. Walker, board chairman and director of National Supply Co., has been elected a director of the company.

Struthers Wells Corp.—Fred W. Emhardt to chief engineer from assistant manager of the process equipment department.

Bellco Industrial Engineering Co.—Harry B. Catlow, from Republic Supply Co. to executive vice-president of Bellco.

Babcock & Wilcox—Ralph K. Behr to manager of the Boston district office of the boiler division, replacing H. K. Dean, who is retiring after 31 years of service with the company.

Honeywell-Brown Ltd.—Edward C. Vorlander to manager director, with headquarters in London, of this British subsidiary of the Minneapolis-Honeywell Regulator Co.

Bonney Forge & Tool Works — Robert Bader to sales engineer at Houston, Texas, for the welding fittings division.

W. H. & L. D. Betz—Bernard F. Shema to chief microbiologist of this firm of industrial water conditioning consultants.

National Foam System, Inc.—L. John May to plant manager, from the general chemical division of Allied Chemical & Dye Corp., Claymont, Del.

Joy Manufacturing Co.—John Lawrence to executive vice-president, from vice-president of manufacturing and engineering.

Suppliers

Black, Sivalls & Bryson, Inc.—Lavelle E. "Buck" Jones to Casper, Wyo., district sales manager; Harrell Bruner, from Salem, Ill., replaces Mr. Jones at Alice, Texas.

Midvale Co.—Howard H. Casey to director of engineering, from general sales manager.

Girdler Co.—Dr. J. E. Taylor, employed by the company from 1942 to 1945, has rejoined the gas process division for work in the development and application of new catalysts.

Rockwell Mfg. Co.—Jack H. Walters, from Houston district sales manager of Meter and Valve Division to gas products manager for the entire division, with headquarters in Pittsburgh; Thomas I. Stacy, sales engineer to manager of the Houston district.

Foxboro Co.—R. S. Yahrmarkt, formerly with the Ethyl Corp. of Baton Rouge, La., to Foxboro's Tulsa, Okla., office as an industrial engineer.

Central Scientific Co.—Gordon Baker, from manager of the Montreal branch of the Canadian subsidiary to manager of the Los Angeles branch, replacing Richard N. Golbach, who has been made director of sales.

Ethyl Corp.—Redgnald D. Bushell to New York district manager.

Dresser Industries, Inc.—E. L. DeGolyer, of DeGolyer & MacNaughton, Dallas, to member of the board of directors.

Brown, Blauvelt & Leonard—Bradford E. Bailey, formerly with Esso Laboratories and the Esso engineering department, to chief chemical engineer.

Henry J. Kaiser Co.—E. T. Larson to vice-president, with responsibility for engineering activities of Kaiser Engineers, a company division; Dr. W. C. Rueckel to vice-president, with title now manager of development and sales, Kaiser Engineers.

Branches, Distributors

Pittsburgh Plate Glass Co. has moved its Manhattan district office from 30 Rockefeller Plaza to 579 Fifth Ave., New York. The new location also contains the New York district sales office of the company's subsidiary, the Columbia-Southern Chemical Corp.

must you pay a premium price for accurate instrumentation?

fielden says, "no!"—

with precise yet sensibly priced instruments like this TELSTOR Electronic Level Indicator. TELSTOR measures continuously—with accuracies to ±2%—the levels of liquids, viscous fluids, powders or granular solids. Remote readings can be recorded at distances greater than one mile.

Fielden TELSTOR Electronic Level Indicator for Accurate, Continuous Level Measurement of Liquids or Divided Solids.

Simplification is the reason for Fielden's economical instrumentation. TELSTOR, for example, has no moving parts—no floats to stick or leak—no pneumatic or hydraulic piping. Circuitry is simplicity itself and only one vacuum tube is employed. Measuring electrode and instrument are easily installed.

Unless you really *need* instrumentation of *extreme precision* (which inevitably costs more) get the facts about Fielden. *Simplified* Fielden instrumentation assures *all the accuracy you can use*—at an extremely worthwhile saving in initial cost and maintenance.

DOLLAR FOR DOLLAR—YOUR BEST INSTRUMENT VALUE

SEND FOR NEW INSTRUMENT DATA TODAY.

Robertshaw-Fulton CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
2920 N. 4th St., Dept. K, Philadelphia 33, Pa.

Send full details of Fielden simplified ☐ TELSTOR Electronic Level Indicator ☐ TEKTOR Electronic Level Control ☐ TEKTOLOG Electronic Recorder.

*Name*_____

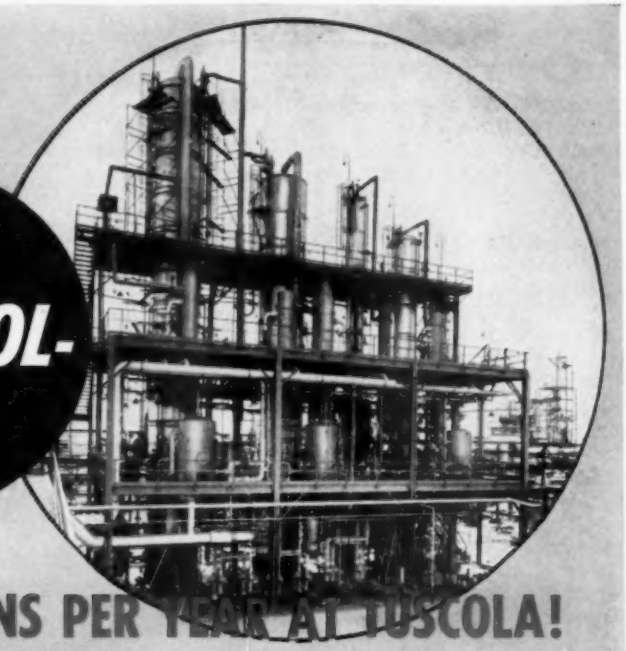
*Title*_____

*Company*_____

*Address*_____ *City*_____ *State*_____

Fielden TEKTOR Electronic Level Control

Fielden TEKTOLOG Electronic Recorder



ETHANOL-

40 MILLION GALLONS PER YEAR AT TUSCOLA!

RESULTS —

Lower Plant Investment

Lower Operating Costs

On Stream — On Time!

Vulcan's basic Process Knowledge and complete Engineering Service made possible this Synthetic Ethanol Plant for National Petro-Chemicals at Tuscola, Ill.

Vulcan Engineering is proud of its major contribution to the huge, new plant of National Petro-Chemicals Corporation. From Vulcan's basic process knowledge, augmented by pilot plant studies, a process for ethanol synthesis has been developed which, at Tuscola, results in an installation of minimum investment and low-cost operation. It was up and ready to function the instant feed material could be brought to it.

SPECIAL FEATURES

Engineers will be interested in several special features of this synthesis plant:

1. *The largest single piece bonded lead-lined steel tower in the country* — possibly the world.
2. *Two complex special alloy-lined absorbers,* which — after manufacturing, shipping and site erection — tested without a single leak.
3. *Special corrosion problem licked.* Extreme corrosion tendencies of sulfuric acid at high temperatures overcome by Vulcan design.
4. *Substantial savings effected* by use of copper-lined steel pressure columns designed and built by Vulcan's Manufacturing Division.
5. *Over ⅓ of the total heat requirement saved* by special Vulcan-designed recovery system.

To other chemical and petro-chemical processors — Whether your interest is in a complete job like this or a more narrowly defined engineering problem, Vulcan Engineering can offer you experienced service in any or all of these areas:

- Preliminary evaluation
- Development and pilot plants
- Project engineering
- Procurement
- Process design and engineering
- Mechanical engineering
- Construction
- Initial operation

VULCAN ENGINEERING DIVISION

The Vulcan Copper & Supply Co., *General Offices and Plant,* CINCINNATI 2, OHIO

NEW YORK BOSTON PHILADELPHIA SAN FRANCISCO

VICKERS VULCAN PROCESS ENGINEERING CO., LTD., MONTREAL, CANADA

DIVISIONS OF THE VULCAN COPPER & SUPPLY CO.:

VULCAN ENGINEERING DIVISION • VULCAN MANUFACTURING DIVISION • VULCAN CONSTRUCTION DIVISION • VULCAN INDUSTRIAL SUPPLY DIVISION

Short-Cuts for Pipe System Analysis

Practical Piping Flexibility—Design and Flow, by W. A. Thomas, 8½x5½ in., x+ 190 pps., 154 illustrations, 72 tables, 31 charts, loose-leaf ring binder, $25. Published in Nov., 1953, by W. A. Thomas, 2742 Philadelphia Ave., Pittsburgh 16, Pa.

ENGINEERS responsible for the analysis of thermal stresses and reactions in piping systems should find this a welcome book, for it is in large part a compendium of ways to make their jobs easier. The author's thesis is that for a great many practical situations precise calculations made with the elastic theory are too much at variance with test results and, consequently, subject to too large an amount of individual interpretation to warrant the time and effort they require.

Instead, he writes in the book's preface, "There is needed for the purpose of uniformity, speed, and safety, a reduction of procedures to a simple and practical degree of approximation for commercial use, in which the safety margin is always automatically included so that as little as possible is left to individual opinion."

The short-cuts provided are not limited to the problem of thermal stresses and reactions in piping systems, though, but also include a variety of aids in two other sections of the book, "Flow of Fluids in Pipes and Pumping" and "Miscellaneous Design Data."

In the first section, "Piping Flexibility," Mr. Thomas presents the graphs and charts he has devised for checking the maximum thermal stress and reactions in piping arrangements between two anchors. He intends this as a check on the results of more detailed analysis, though it can serve as the major tool for ordinary problems if a very close check is not needed. Related to this is an "Analysis Criterion Chart," to show at a preliminary stage whether a piping system needs further analysis. If further work is indicated, the piping system is then selected from a table of key shapes, and the coefficients obtained from the table are used in two master charts to find the maximum stress and the reactions.

In "Flow of Fluids in Pipes and Plumbing" there are formulas, charts and tables covering the flow of water, steam up to critical pressure, and viscous liquids. One chart gives steam pressure drops, another the velocity and most economic pipe size. Viscous liquid flow tables occupy 18 pages covering pipe sizes from 1 in. to 24 in. inclusive, with the region of critical flow between streamline and turbulent flow indicated. A chapter is given to the effect of viscosity on pump efficiency, and a chart provides a way of making a quick calculation for viscosities between 0.5 and 10,000 centipoises.

Text material on the economical size of a pipeline is also in this section, and a direct equation with 14 variables —including the cost of the pump—is developed. A table and chart are given as a rapid method of calculation.

The third major division of the book is on miscellaneous design data and includes, among many others, the following short-cuts: for calculating thermal stress in plates, bars, and cylinders; approximating the maximum stress in transversely loaded flat plates of regular and irregular boundaries; determining the stresses in vessels due to supports; proportioning pipe flanges; and for determining the deflection of centrally loaded fixed edge circular flat plate when the deflection is larger than valid by bending formulas.

The book's final section consists of a bibliography of source materials on piping flexibility.

New Gas Institute Work on Research With Shale Oils

THE pamphlet "Production of High-Btu Oil Gases from Crude Shale Oils" is an interim report of an investigation conducted by the Institute of Gas Technology under the sponsorship of the American Gas Association. The objectives of the study were two: to extend to typical domestic shale oils the relationships between oil properties, cracking conditions and product yields found in an earlier institute investigation, and to determine to what extent shale oil gases produced under typical high-Btu oil gas operating conditions can be substituted for high-methane natural gas.

This interim report contains experimental data obtained in the thermal gasification of two typical crude shale oils in a 2.5-inch ID externally heated laboratory cracking tube. The range of cracking conditions used resulted in the production of gases with heating values from 900 to 1500 Btu/SCF. Runs were made at atmospheric pressure, using steam for atomization and partial pressure control, at cracking temperatures from 1400° to 1550° F., and residence times from 2 to 4.5 seconds.

The oil gas yields from shale oil were found by the investigators to be approximately the same as those obtained from petroleum oils of equivalent carbon-hydrogen ratio. Furthermore, it was found that shale oil, when scrubbed and blended with inerts to the desired heating value and specific gravity, had equal or greater ability to be substituted for high-methane natural gas than petroleum oil gases of the same heating value.

The 24-page report contains numerous graphs showing gasification results for crude shale oils and comparing these with similar data obtained for distillate and residual petroleum oils. Other graphs illustrate the effects of severity of cracking on Btu recoveries in the form of stable product gas, and on the yields and composition of gaseous and nongaseous products. Full information is given on the problem of the substitution of scrubbed shale oil gases.

The report is available from the Institute of Gas Technology, 17 W. 34th St., Technology Center, Chicago 16, Ill. Its price is $2.50.

Book on Tower Packings, Design in Revised Edition

Tower Packings and Packed Tower Design, Second Edition, by Max Leva, 8x10½ in., xvii + 214 pps., 115 illustrations, stiff cloth binding, $8.50. Published by the United States Stoneware Co., Akron 9, Ohio.

A CONSIDERABLY expanded second edition of a work that aroused wide interest when it was first published in 1951, this volume organizes in an attractive presentation the fundamental details about packed towers and their operation, and covers the bulk of data and the basic methods used in designing them.

For those familiar with the first edition, the additions to the present volume may be summarized briefly: a larger amount of technical data of a general nature has been included; the literature is reviewed more comprehensively; there is more material on pressure drop, flooding, and hold-up, as well as a broader discussion of tower auxiliaries; and the section on distillation has been enlarged.

The author also has taken into account the findings of recent British research in his chapter on data generalization, and particularly in his treatment of liquid-liquid contacting. A decision was made against including information on cost in this edition, despite requests for it, because, in the author's words, "Market prices may not remain sufficiently stable in a relative sense to permit the laying down of generalizations."

After a brief chapter on some general considerations, the subject of the

Headquarters for PETROLEUM TESTING EQUIPMENT used by

• REFINERIES
• PETROCHEMICAL PLANTS
• GASOLINE PLANTS

W. H. CURTIN & CO.
DOMESTIC EXPORT • LABORATORY APPARATUS & CHEMICALS
HOUSTON • NEW ORLEANS
TULSA • BIRMINGHAM • U.S.A.

HERE'S HELP
for technical and business men

NEW 1954 Catalogue of McGRAW-HILL BOOKS

Describes over 2000 books

Here is a guide to practical, expert information on many business and technical subjects. This catalogue contains clear, concise descriptions of more than 2000 books written by leaders of business, industry, and research. Get your copy now. In it you will find an up-to-date listing of books that give you facts, experience, and data you need in solving your particular problems.

McGraw-Hill books bring you the experience of experts in your field

Mail this coupon for your FREE copy

McGRAW-HILL

Readers' Service Dept.
McGraw-Hill Book Co., Inc.
327 W. 41st St., N.Y.C. 36

Send me a free copy of the new 1954 Catalogue of McGraw-Hill books. I want to know more about: (Name subjects of most interest to you.)

.....

.....

Name .....

Street .....

City ..... State PPET-54

mechanics of packed tower operation is taken up. The principle types of packing are discussed and illustrated, and detailed specifications given for Raschig rings, Lessing rings (ordinary, ceramic and metal), cross-partition rings, spiral packing rings, Berl saddle packings, and Intalox saddle packings. Under auxiliaries there is a discussion of distributor plates, redistributors, and support plates.

In the following section a mass of experimental data on pressure drop is presented in a number of graphs showing the drop for single-phase flow under different conditions with a variety of packing materials. Factors influencing pressure drop are examined, and correlation tables for gas-liquid systems and liquid-liquid systems follow. The final parts of the chapter have discussions of hold-up; loading and flooding; internal liquid distribution; the question of packed towers vs. plate towers; and, in conclusion, there is a section with nine illustrative problems.

In the next chapter, "Fundamentals of Mass Transfer," the author takes up methods of design and capacity coefficients from the standpoint of the tower's ability to bring about mass transfer by way of diffusion. Here he considers the driving force, height of a transfer unit, methods of evaluating the number of transfer units, non-isothermal absorption, and other topics.

A chapter on data generalization follows in which methods for correlating the capacity coefficients for different systems are given. Correlations for liquid-film and gas-film coefficients are worked out and demonstrated in illustrative problems. Effect on the capacity coefficient of the chemical reaction occurring during gas-liquid exchange is analyzed next, as is the effect of surface tension on the liquid-film coefficient in the succeeding part.

Capacity coefficient data for some common systems are compiled in the next chapter, "Absorption Data and Packing Performance," along with a discussion of the performance of various packings.

The final chapter is an extensive consideration of distillation as it pertains to packed towers. Among the subjects raised are Raoult's Law, azeotropes, relative volatility, packed column evaluations, HETP correlations, and others. Literature citations and a glossary follow this chapter.

The appendix contains a great deal of additional material, including an extensive section on tower construction that is illustrated with full-page cross-sections of towers of different design. A partial list of the other material includes: ASTM specifications for chemical-resistant masonry, conversion factors, temperature conversion tables, and density graphs of aqueous inorganic salt solutions, bases, and acids.

Plant Maintenance Volume For 1954 Is Published

Techniques of Plant Maintenance and Engineering, 1954; 8½x11 in., 291 pp., stiff cloth binding, $7.50. Clapp & Poliak Inc., 341 Madison Ave., New York, N. Y.

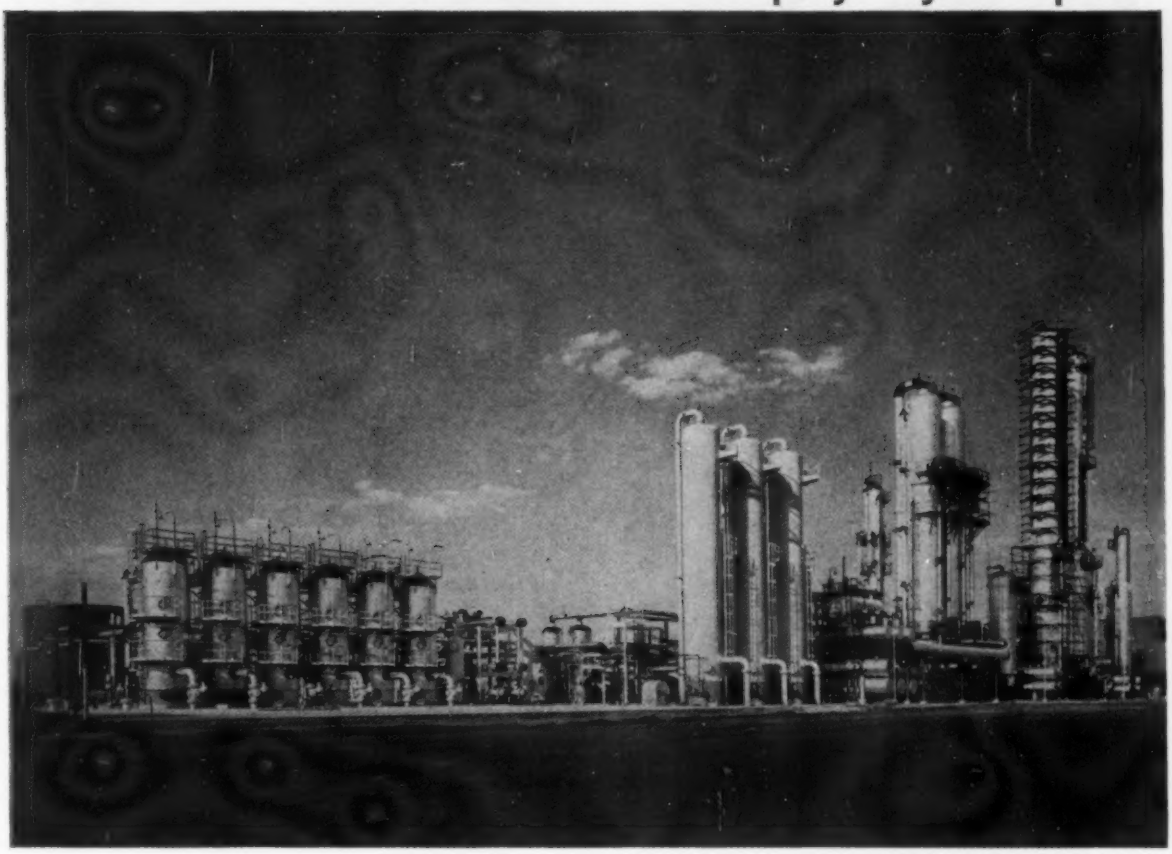
THE appearance of this volume each year marks the occasion of another Plant Maintenance and Engineering Conference, which was held this year concurrently with the National Plant Maintenance and Engineering Show in Chicago. It contains all the papers read at the conference, transcripts of the discussion that followed many of them, and summaries of the 20 round-table meetings dealing with special topics. Any exhibit material connected with the papers delivered is reproduced in the volume, and the contents are attractively presented.

The two general sessions of the conference heard discussions of planning and scheduling maintenance work—beginning with general remarks and illustrated by case studies of plants having 150 and 1100 employees—and maintenance cost control and budgeting, supporting material here being case studies of a plant with 650 employees and one with 2300 employees.

In the sectional conferences the following subjects were taken up: preventive maintenance—pro and con; training people for maintenance work; organizing people, policies and procedures for effective maintenance; maintenance by area compared with centralized maintenance; sanitation—methods, materials and controls; the place of sanitation in plant maintenance; insecticides and rodent control; occupations dematitis—cost and control; cost of sanitation and methods of cost analysis; work measurement, work standards and incentives; getting management's o.k. on the maintenance program; problems met in handling maintenance labor; corrosion control and prevention; hospitals, medical departments, and first-aid rooms; and waste disposal problems and solutions.

Round-table discussions at the 1954 conference numbered 20 and included evaluations of the maintenance problem in a variety of installations and with several types of equipment. Among the topics raised were the following: electronic control equipment; lubrication—methods, systems, lubricants; plant buildings; power plant equipment; chemical plants; and petroleum refining plants.

Petro starts construction work on polyethylene plant



NATURAL GAS EXTRACTION UNIT

The emergence of National Petro-Chemicals Corporation in 1955 as a large scale polyethylene producer will be a natural outgrowth of the entire Petro operation. From pipeline gas to polymer, the plant at Tuscola, Illinois will be an integrated unit processing ethane to ethylene to polyethylene. Only in this way can continuity of supply be assured, and quality controlled in full.

The polyethylene plant is being constructed by The M. W. Kellogg Company, and is based on a process developed by ICI and modified by Petro to fit specific conditions. Recycling of gases is eliminated to insure a product of the highest quality.

A new process control, product application and research laboratory is also under construction at Tuscola to augment present knowledge and to improve product and process after production gets underway. These facilities are designed for prompt, efficient service to polyethylene users in their processing problems.

This new product, "Petrothene", will be available in June, 1955. From the centrally located plant, immediate shipments can be made to any part of the country —direct by truck or rail. Bulk shipments will also be handled.

Because Petro believes in the future of polyethylene, the unit has been geared to a three to four-fold production increase. As new uses are developed, this additional production will be needed, and Petro will be there to serve your expanding markets.

"PETROTHENE"... THE POLYETHYLENE OF TOMORROW

NATIONAL PETRO-CHEMICALS

CORPORATION

A joint enterprise of National Distillers Products Corporation and Panhandle Eastern Pipeline Company

99 PARK AVENUE, NEW YORK 16, N. Y.

 (To obtain more data on advertised products see page 1464)

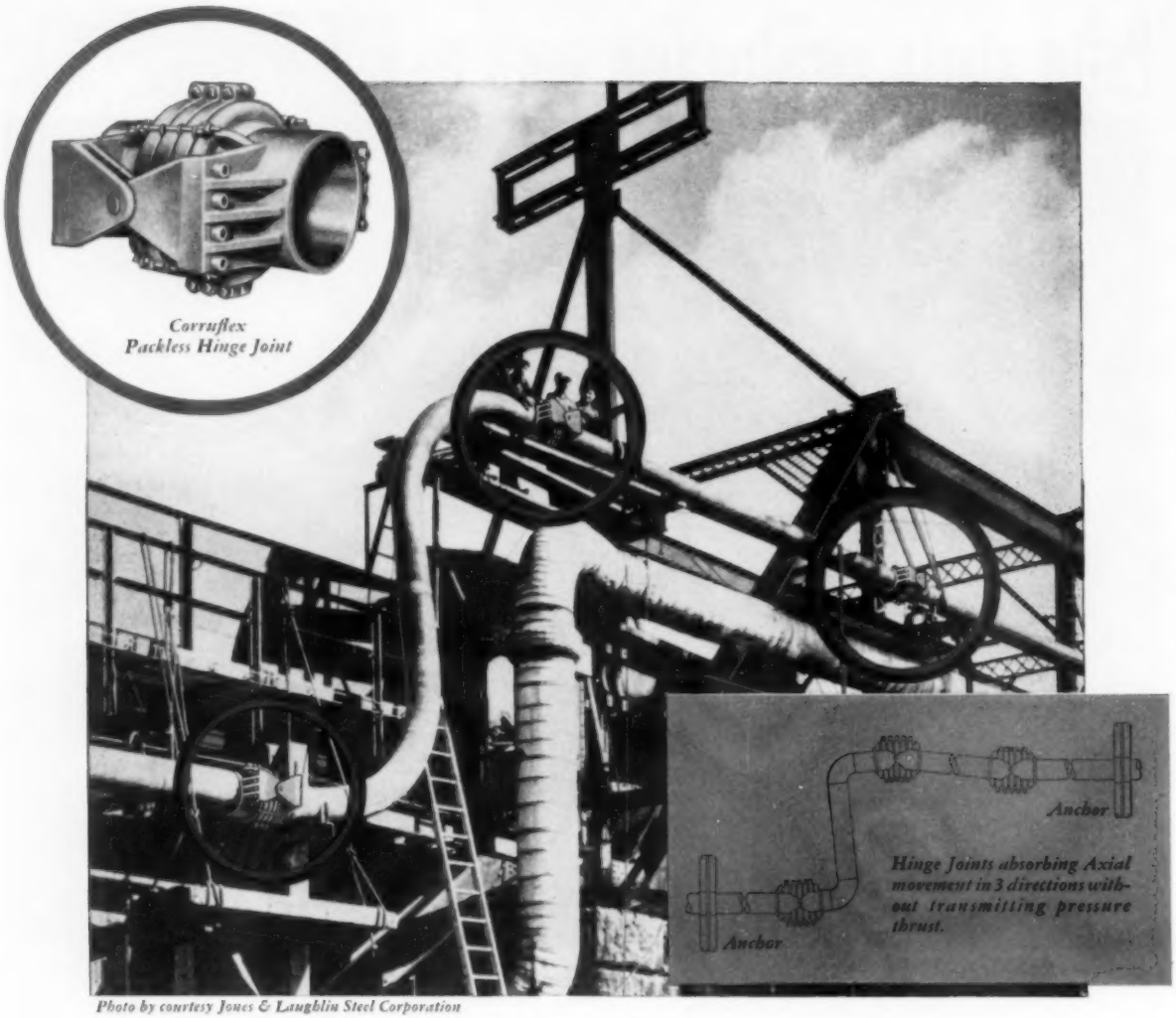


Photo by courtesy Jones & Laughlin Steel Corporation

HINGING A 14" STEAM LINE

● The Jones & Laughlin Steel Corp. in Pittsburgh last year had an excess of steam on one side of the Monongahela River and not enough on the other, where it was vitally needed. To correct this condition, J & L engineers planned to construct a high-pressure, superheated steam line along existing bridges and trestles to transmit the excess of steam to the other side.

However, a great difficulty soon appeared. If conventional expansion joints or loops were used at the 90° turns, pressure thrusts at anchor points would have been great enough to damage the bridges and trestles and actually cause these structures to collapse into the river.

Obviously, something else had to be used. With the aid of Adsco's Engineering Department, J & L "hinged" the pipe line with Corruflex Hinge Joints. These joints cannot develop pressure thrust because their two ends are held apart. They permit movement of a pipe line while keeping anchor loads at a minimum. When used properly, as pictured here, they will permit axial motion of one section of pipe line by permitting angular motion of another section.

Hinge Joints are only one type in the diversified Corruflex line of packless expansion joints. If you have a pipe expansion problem, consult Adsco. Making the world's most complete line of expansion joints, both slip and packless, Adsco will have the right answer.

ADSCO ENGINEERED PRODUCTS

AMERICAN DISTRICT STEAM COMPANY, INC.

GENERAL OFFICES
NORTH TONAWANDA, NEW YORK
PLANTS
NORTH TONAWANDA, N. Y., AND RICHMOND, CALIF.

ASME Plans Full Program for Annual Petroleum-Engineering Conference

The petroleum division of the American Society of Mechanical Engineers will offer another varied program at the petroleum mechanical engineering conference to be held in the Statler Hotel, Los Angeles, from September 26 to 29. Technical sessions of this ninth annual conference will start September 27, and have been divided into three parts—refining, production, and transportation—which will run concurrently during the morning and afternoon hours. Discussions of materials will replace transportation sessions on Tuesday and Wednesday mornings.

Papers of special interest to petroleum processing technologists are as follows:

MONDAY, SEPTEMBER 27

Session 1—9:00 a.m.

Mechanical Features of the Hyperforming Process, Clyde Berg, manager of process development, Union Oil Co. of California.

Mechanical Advancements in the Alkylation Process, Robert Stiles, process engineer, M. W. Kellogg Co.

Session 2—9:00 a.m.

Excavating Underground Storage for Petroleum Products, R. L. Loffbourow, consulting engineer, Minneapolis, Minn.

In-Situ Combustion Oil Recovery Process,, R. L. Koch, J. F. Gleason, W. G. Boston, field research laboratories, Magnolia Petroleum Co.

Session 4—2:00 p.m.

Influence of Process Variables on Utility Requirements and Selection of Pumps, R. S. Custer, chief process engineer, Refinery Engineering Co.

Design Problems and Applications of High Speed Turbine Drives, H. Steen-Johnsen, chief engineer, turbine division, Elliot Co.

TUESDAY, SEPTEMBER 28

Session 7—9:00 a.m.

Field Coordinating Organization for Improving Efficiency of Petroleum Refinery Maintenance, E. C. Hermann, head of maintenance and construction, Bayway Refinery, Esso Standard Oil Co.

Field Welding of Heavy Wall Vessels, F. A. Upson, head inspection engineer, Whiting Refinery, Standard Oil Co. (Ind.).

Session 9—9:00 a.m.

The Influence of High-Strength Materials on the Design and Fabrication of Multi-Layer Vessels, G. E. Fratcher, chief engineer, process equipment division, A. O. Smith Corp.

Session 10—2:00 p. m.

The American Standard Code for Pressure Piping, F.S.G. Williams, manager of engineering standards, Taylor Forge & Pipe Works.

WEDNESDAY, SEPTEMBER 29

Session 13—9:00 a.m.

Allowable Membrane Stresses for Welded Carbon Steel Boiler Pressure Vessels, W. P. Kerkof, Asiatic Petroleum Corp.

Stresses From Local Loadings in Cylindrical Pressure Vessels, P. P. Bijlaard, professor of structural engineering, Cornell University.

Space Supports—The Circular Pedestal, N. A. Weil, development engineer, J. J. Murphy, development section manager, M. W. Kellogg Co.

Session 15—9:00 a. m.

The use of Metallic and Non-Metallic Linings for Pressure Vessels in Refinery Service, S. J. Artese, Shell Oil Co.

Glass Coating as a Corrosion Barrier, W. A. Deringer, director, ceramic-organic research and development, A. O. Smith Corp.

Hydrogen Blistering and Preventive Measures, Filipe Parades, metallurgical engineer, El Paso Natural Gas Corp.

Session 16—2:00 p. m.

A Look Ahead in Pressure Vessel Design, E. W. Jacobson, chief design engineer, Gulf Research and Development Co.

Four Industry Groups to Sponsor Symposium on Testing of LPG

Four association groups will combine their efforts September 27 and 28 to present for the first time in the industry a symposium on methods for testing liquefied petroleum gases. The location is to be the Statler Hotel in St. Louis, Mo., and the interested organizations are the Natural Gasoline Association of America, the California Natural Gasoline Association, and two committees of the American Society for Testing Materials—D-2 on petroleum products and D-3 on gaseous fuels.

A display of specialized LPG-testing equipment will be presented in conjunction with the symposium. Papers to be heard during the two days are:

Low Temperature Distillation Analysis of LPG—W. J. Podbielniak, Podbielniak, Inc.

Determination of Trace Amounts of Carbonyl Sulfide in Gaseous Hydrocarbons—Robert E. Snyder and Ralph O. Clark, Gulf Research and Development Co.

Determination of Total Volatile Sulfur in LPG Products—J. E. Walker, Humble Oil and Refining Co.

Determination of Water in LPG by Acetyl Chloride—J. E. Walker, Humble Oil and Refining Co.

Determination of Free Sulfur in LPG—J. F. Hickerson, W. B. Lewis and B. J. Davidson, Humble Oil and Refining Co.

Determination of Individual Mercaptan Compounds in LPG—J. F. Hickerson and W. B. Lewis, Humble Oil and Refining Co.

Determination of Mercaptans and Hydrogen Sulfide in LPG—M. W. Scoggins, M. D. Grimes, J. E. Puckett and P. F. Warner, Phillips Petroleum Co.

Determination of Hydrogen Sulfide and Free Sulfur in LPG—W. H. Alderson, B. A. Eckerson, and J. G. Foulds, California Research Corp.

Specific Gravity of Commercial Propane from Correlations With Vapor Pressure and Olefin Content—W. H. Alderson and H. I. Allen, California Research Corp.

LPG Testing—Some Notes on Current United Kingdom Procedures — The Petroleum Gases Panel of the Institute of Petroleum.

Installation of Equipment for Detecting Light Hydrocarbons in Cooling Water—J. W. Moore, Sinclair Rubber Co.

Mass Spectrometry for LPG Analyses—A. P. Gifford, Consolidated Engineering Corp.

Application of Infrared Methods to Light Hydrocarbon Gas Analysis—P. A. Wilks, Perkin Elmer Corp.

Application of Infrared Techniques to Petroleum Gases—W. A. Patterson, Baird Associates.

Physical Properties and Analysis of Lower Hydrocarbons, A Review—R. K. Robey, Standard Oil Development Co.

LPG Testing from A Transit User Viewpoint—C. W. Ricker, Jr., Chicago Transit Authority.

Determination of Water by Dew Point—S. W. Burdick, Carbide and Carbon Chemical Co.

Analysis of LPG Gases by Fractional Absorption—L. V. Guild, Burrell Corp.

LPG Moisture Testing by A Modified Dew Point Method—W. A. Hartmann, Phillips Petroleum Co.

An Improved Design of LPG Pycnometer—Dan E. Smith and E. J. Gatchell, Phillips Petroleum Co.

Factors Affecting the Cobalt Bromide Test for Water in Propane—R. M. Gentry and V. H. Gunther, Shell Oil Co.

Determination of Small Quantities of Air in the Vapor Phase of Cylinders Containing LPG—H. W. Tompkins and V. R. Ratzlow, Phillips Petroleum Co.

Methods of Analysis of LPG—J. A. Estes, The Texas Co.

An Analyzer-Recorder for Measuring Hydrogen Sulfide in Air and Hydrocarbon Gases—E. B. Offutt, Robert-Shaw Fulton Controls, and L. V. Sorg, Standard Oil Co.

Determination of Elemental Sulfur in LPG—J. B. Gregory and G. Matsuyama, Union Oil Co. of California.

Sampling—S. Schuhmann, National Bureau of Standards.

Safety in the Field of Transportation—Andrews Butane Co.

Oxygen Lamp for Sulfur Analysis—D. M. Mason and C. E. Hummel, Institute of Gas Technology.

Continuous Sulfur Measurement—Henry Landsberg and Edward E. Escher, Consolidated Engineering Co.

Estimation of Oxygen in Hydrocarbon Gases—Harner Eby, Universal Oil Products.

Sampling for Safety—M. W. Hartz, Mine Safety Appliance Co.

An Improved LPG Hydrometer—L. C. Jernigan, Warren Petroleum Co., W. Chandler, Chandler Engineering Co.

Weathering Tests—Harry Thomas, Tuloma Gas Products Co.

Corrosion Testing, Review of NGAA Studies—D. A. Schock, Continental Oil Co.

Water by Cobalt Bromide Test—J. W. Martin, Shamrock Oil and Gas Corp.

Determination of Contaminants in Propane and Butane—W. R. Dietz, National Petro-Chemical Corp.

Operating Practices to Be Topic of NGAA Meeting

The Oklahoma City regional meeting of the Natural Gasoline Association of America will be held September 17 at the Skirvin Hotel, Oklahoma City, and will feature a number of papers leaning to the practical side of refinery operation.

The first of these, "Operating Experience with Package Plants," will be delivered by J. T. Bailey, Sohio Oil Co., Oklahoma City. E. C. Mannas, Continental Oil Co., Oklahoma City, will follow with a discussion of "Plant Stream Testing for Operating Men."

A panel discussion on "Practical Aspects of Water Treating," will bring together J. S. Connors, Phillips Petroleum Co., Bartlesville; J. W. Kilmer, Stanolind Oil & Gas Co., Tulsa; and L. M. Mauney, Warren Petroleum Corp., Tulsa. Moderator will be R. G. Boatright, Phillips Petroleum Co.

A talk on "Good Practice at Loading Racks" will be given by Thedus Raper, Warren Petroleum Corp., Maysville, Okla. Two other speakers on general topics are also scheduled to be heard.

The Natural Gasoline Supply Men's Association will be host for the usual "Cooling Tower," and the regional meeting will close with a dinner and entertainment.

IOCA to Hold Annual Meeting in Chicago

The Independent Oil Compounders Association will hold its seventh annual meeting at the Sheraton Hotel in Chicago, September 27 and 28.

Included in the tentative program so far arranged for the gathering are a paper by T. R. Roberts, of Rheem Mfg. Co., describing a special arm for fork-lift trucks which makes it unnecessary to use pallets in handling filled or empty containers in refineries and warehouses, and another paper by J. R. Stitt, of Oronite Chemical Co., on motor oils.

Program Set for AIEE Petroleum Conference

The program has taken its final shape for the American Institute of Electrical Engineers' first electrical conference of the petroleum industry, to be given September 27 to 29 at the Mayo Hotel in Tulsa, Okla. A number of papers of interest to petroleum processing engineers will be presented during the conference, including the following:

Training of Maintenance Personnel at Socony-Vacuum Refinery, E. St. Louis, Ill., A. J. Claes, Socony-Vacuum Oil Co., E St. Louis, Ill.

Some Features of Power Systems for Oil Refineries, H. M. Stewart, Humble Oil & Refining Co., Baytown, Texas.

Lighting Protection in Petroleum Refineries and Chemical Plants, James V. Cundelan and Ernest C. Benjamin, M. W. Kellogg Co., New York.

The Background, Intent, and Application of the Rules Contained in Article 500 of the National Electrical Code, C. M. Park, Mill Mutual Fire Prevention Bureau, Chicago.

Illustrated Lecture on Typical Explosion-Proof Installations, R. B. West, Blaw- Knox Co., Tulsa, Okla.

Application of Large AC Motors and Control to Refineries and Pipelines, G. L. Oscarson, Electric Machinery Mfg. Co., Minneapolis, Minn. A discussion of this paper by C. F. MacGinnis, Elliot Mfg. Co., Ridgeway, Pa., will follow.

Uses of Radioactive Substances in the Petroleum Industry, William Jarzembski, Jarco Services, Inc., Tulsa, Okla.

Use of Electric Heating in Relation to Paraffin Problems, Grafton A. Smith, Shell Oil Co., Tulsa.

Electric Equipment Maintenance Costs, Motor Control for Indoor and Outdoor Applications, Tom L. Scott, Phillips Petroleum Co., Bartlesville, Okla.

A stag buffet banquet Tuesday evening, September 28, will be addressed by A. C. Monteith, Westinghouse Electric Corp., E. Pittsburgh, Pa., president of AIEE. Other speakers at the conference will be the Hon. Johnston Murray, governor of Oklahoma, Maj. A. N. Horne, Texas-Empire Pipe Line Co., and Mayor Clark, of Tulsa.

Oil Man's Calendar

SEPTEMBER

Natural Gasoline Assn. of America, Oklahoma regional meeting, Skirvin Hotel, Oklahoma City, September 17.

1st International Instrument Congress and Exposition, Commercial Museum and Auditorium, Philadelphia, Pa., Sept. 13-24.

National Petroleum Ass'n, 52nd annual meeting, Hotel Traymore, Atlantic City, N. J., September 15-17.

Western Petroleum Refiners Assn., regional meeting, Henning Hotel, Casper, Wyo., September 23 and 24.

American Institute of Electrical Engineers, first conference on the petroleum industry, Tulsa, Okla., September 27-29.

Independent Oil Compounders Assn., 7th annual meeting, Hotel Sheraton, Chicago, September 27-28.

Symposium on Methods for Testing Liquefied Petroleum Gases, Hotel Statler, St. Louis, Mo., September 27-28.

American Society of Mechanical Engineers, ninth annual petroleum mechanical engineering conference, Statler Hotel, Los Angeles, Calif., September 27-30.

OCTOBER

American Institute of Chemical Engineers, New York Section, symposium on new developments in the petroleum and chemical industries and cost estimation, Hotel Statler, New York City, October 13.

Natural Gasoline Assn. of America, southern regional meeting, Blackstone Hotel, Tyler, Texas, October 29.

Sinclair Weeks Heads NPA Meeting Program

Sinclair Weeks, Secretary of Commerce, Charles F. Kettering, of General Motors, and Chester F. Smith, of Standard Oil of New Jersey, will be among the speakers at the National Petroleum Association's 52nd annual meeting, to be held at the Hotel Traymore, Atlantic City, September 15-17.

The program will be opened at 2 p.m. Wednesday afternoon by A. W. Scott, association president. Then Mr. Smith will deliver his address, "A World-Wide Look at the Changing Flow of Oil." He will be followed by Mr. Kettering, and the session will conclude with the showing of the Oil Industry Information Committee's New film, "The Story of Colonel Drake."

Thursday's session will be opened with an address by Secretary Weeks, who will discuss some of the business problems confronting the administration. General Thompson, chairman of the Texas railroad commission and a leading proponent of government-industry cooperation to safeguard U.S. oil reserves, will state his views on this topic in his talk, "Imports, Their Effect on National Defense."

The technical session in the afternoon will feature a symposium on multi-viscosity grade motor oils, with R. K. William, General Motors Corp., C. W. Georgi, Quaker State Oil Refining Corp., R. Overcash and W. Hart, Kendall Refining Co., and J. F. Socolofsky, Socony-Vacuum Oil Co., participating.

A session on transportation, also scheduled for Thursday afternoon, will hear a discussion of the effects of private transportation on the costs of common carrier transportation by Kenneth E. Tuggle, a member of the interstate commerce commission, and H. O. Mathews, of Armour and Co.

The association's annual banquet will be given Thursday night, and the Ethyl Corp.'s annual breakfast party is scheduled for Friday morning.

"RETAINED VOLATILITY" Seasons YOUR MOTOR FUEL

Make certain your Motor Fuel loses none of its high quality before or after it gets into the customer's tank.

Blending with NATURAL GASOLINE will "season" your product with RETAINED VOLATILITY.

You can depend on WARREN'S production, transportation, storage and SERVICE for the quality and quantity of NATURAL GASOLINE you need — when and where you want it.

WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN
TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

ACTIVATED ALUMINA for hydrogen fluoride alkylation, brochure on aluminum chemicals; Reynolds Metals Co. See adv't. p. 1471.

ADDITIVE, furnace oil, rust-inhibiting, samples and product data; Oronite Chemical Co. See adv't, p. 1339.

BUBBLE CAPS and risers, catalog 54; Pressed Steel Co. See adv't. p. 1492.

CATALYST for reforming, brochure "Catforming;" Atlantic Refining Co. See adv't. p. 1328.

CLAD STEELS, for corrosion resistant service, color movie; Lukens Steel Co. See adv't. p. 1476.

CLEANING COMPOUND, for heat exchangers and condensers, handbook; Oakite Products, Inc. See adv't. p. 1440.

COKE HANDLING equipment, scrapers, etc., brochure; Sauerman Brothers, Inc. See adv't. p. 1296.

CONDUIT, aluminum, rigid, new booklet; Alcoa Aluminum. See adv't. p. 1488.

CORROSION INHIBITOR, "Polyrad," a filming amine inhibitor, brochure; Hercules Powder Co. See adv't. p. 1480.

COUPLINGS and joints, flexible, made of "Teflon," bulletin FC-952; U. S. Gasket Co. See adv't. p. 1308.

ENTRAINMENT SEPARATORS, wire-mesh type, case study 1004; Otto H. York Co. See adv't. p. 1354.

ETHYLENE PETROCHEMICALS, Ethylene Oxide, Ethylene Glycol, Diethylene Glycol, 33 page bulletin on properties, uses, etc.; Nitrogen Div., Allied Chem. & Dye Corp. See adv't. p. 1434.

FABRICATED STEEL for refinery equipment, general catalog; Flint Steel Corp. See adv't. p. 1486.

FITTINGS, "Swagelok" catalog; Crawford Fitting Co. See adv't. p. 1437.

FLOOR MAINTENANCE, polishers and scrubbers, explosion-proof, information; Lincoln-Schlueter Floor Mach. Co. See adv't. p. 1489.

GENERATORS, oxygen-nitrogen, brochure "Low Temperature Processing;" Air Products, Inc. See adv't. p. 1315.

GREASE THICKENER, Estersil GT, samples and information; DuPont Co. See adv't. p. 1438.

HEAT EXCHANGERS, air cooled, bulletin FF-FD-0.002; The Fluor Corp., Ltd. See adv't. p. 1314.

HEAT TRANSFER equipment, bulletin; Henry Vogt Machine Co. See adv't. p. 1479.

HYDROGEN measurement in liquid hydrocarbons with radioisotopes, bulletin 115; Central Scientific Co. See adv't. p. 1343.

INSULATION, industrial, 4 data books; Philip Carey Mfg. Co. See adv't. p. 1353.

JOINTS, expansion, self-equalizing, bulletin 351; Zallea Brothers. See adv't. p. 1351.

LEAD for sulfuric acid corrosion, booklet "Chemical Lead Products;" National Lead Co. See adv't. p. 1491.

LEVEL INSTRUMENTS, for control and indication, 3 catalogs; Fielden Instrument Div. See adv't. p. 1453.

MATERIAL HANDLING, "Truckster" for light hauling, illustrated booklet; Cushman Motor Works. Inc. See adv't. p. 1451.

MIXERS, for all fluid mixing applications, 4 catalogs, series 16; Eastern Industries, Inc. See adv't. p. 1334.

MIXERS, side and top entering, various types and sizes, 9 catalogs; Mixing Equipment Co. See adv't. p. 1356.

MOTOR STARTERS, for hazardous and semi-hazardous locations, booklet 1062; Electric Controller & Mfg. Co. See adv't. p. 1473.

PAINT, aluminum, rust preventing, booklet "Painting With Aluminum;" Alcoa Aluminum. See adv't. p. 1443.

PUMPS, for various flows up to 600 gpm, information; Ampco Metal, Inc. See adv't. p. 1321.

PUMP PACKING, metallic and semi-metallic, file DMPP; Durametallic Corp. See adv't. p. 1478.

PIPE CUTTER, hinged, for steel and cast iron pipe, descriptive literature; Reed Mfg. Co. See adv't. p. 1451.

PIPE, fittings and valves, "Saran-Lined," corrosion resistant, catalog; Saran Lined Pipe Co. See adv't. p. 1470.

PRESSURE MEASUREMENT and transmission, bulletin 98097 on "Transaire" transmitter, Taylor Instrument Cos. See adv't. pp. 1326-1327.

REFRACTORY LINING, hydraulic setting, for gun or slap-trowel, brochure RC-28A; Johns-Manville. See adv't. p. 1477.

SAFETY HEADS and rupture discs, literature; Black, Sivalls & Bryson, Inc. See adv't. p. 1490.

STAINLESS STEEL, for refinery equipment, booklet; U. S. Steel Corp. See adv't. p. 1495.

STEAM TRAPS, high and normal pressure models, impulse type, bulletin T-1740; Yarnall-Waring Co. See adv't. p. 1494.

STEAM TRAPS, reference catalog 953; W. H. Nicholson & Co. See adv't. p. 1305.

SULFUR DIOXIDE, for processing, samples and specifications; Tennessee Corp. See adv't. p. 1436.

TANK HEATERS, vertical mounting, bulletin 541; Brown Fintube Co. See adv't. p. 1307.

TEMPERATURE RECORDERS, catalog; Electric Auto-Lite Co. See adv't. p. 1478.

THERMOMETERS, mercury actuated, dial and recording types, catalog information; Palmer Thermometers, Inc. See adv't. p. 1442.

TUBES, condenser, new "Opportunity" booklet; Wolverine Tube. See adv't. p. 1483.

TUBES, condenser, publication B-2; The American Brass Co. See adv't. p. 1324.

TURBINES, mechanical drive, bulletin GEA-4955A; General Electric. See adv't. pp. 1332-1333.

VALVE POSITIONER, for dampers and slide valves, bulletin 1-86; Askania Regulator Co. See adv't. p. 1441.

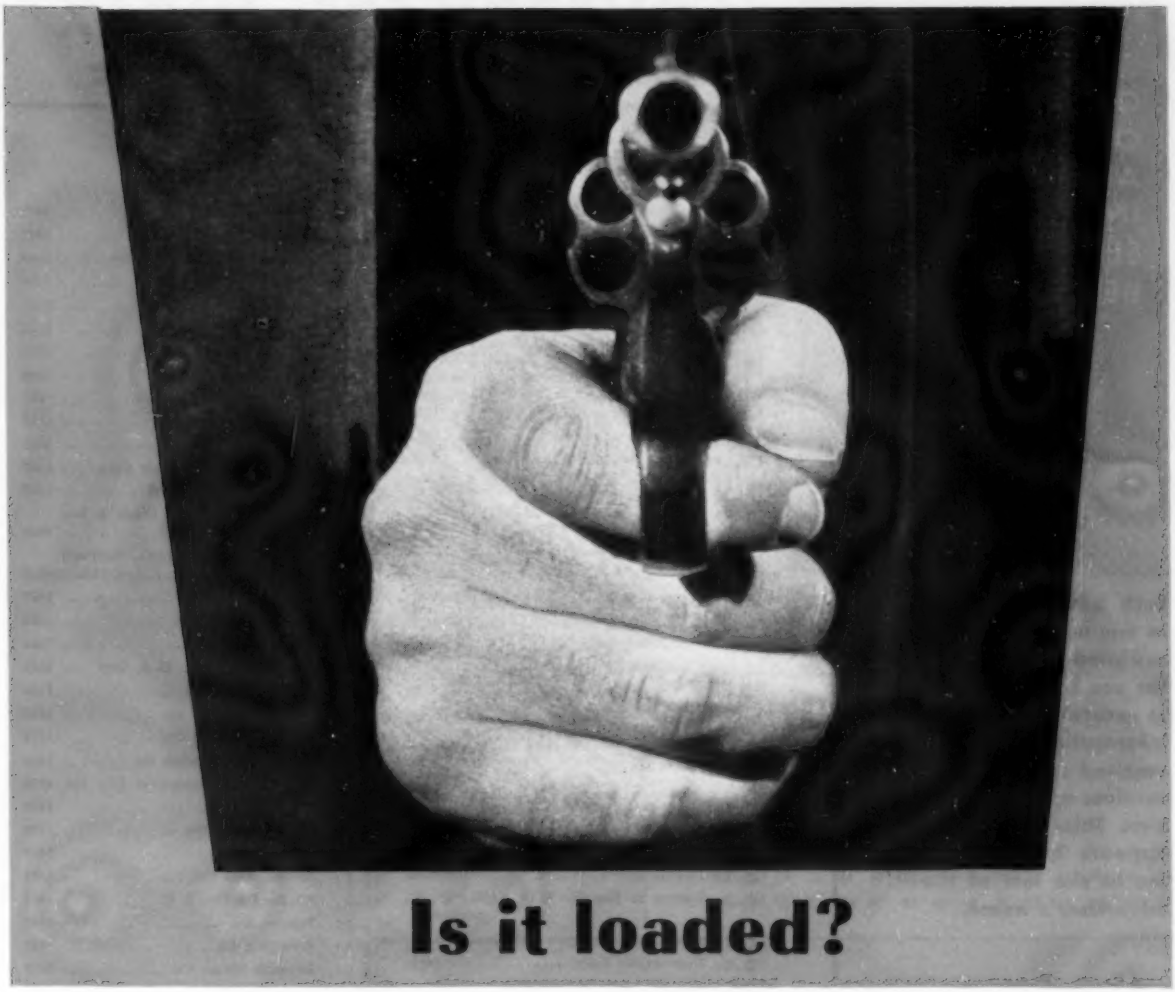
VALVES, gate, lubricated plug, catalog folder; Ohio Injector Co. See adv't. p. 1344.

VALVES, iron body, wedge disc, clamp gates, folder AD-1667; Crane Co. See adv't. p. 1378.

VALVES, "Lever-Seald," tapered plug, catalog 39-3; Homestead Valve Mfg. Co. See adv't. p. 1481.

WATER SEPARATORS, for refinery applications, process manual R-101-53; Warner Lewis Co. See adv't. p. 1482.

WELDING ELBOWS with straight ends, catalog 54; Midwest Piping Co., Inc. See adv't. p. 1444.



Is it loaded?

No, this gun had no bullets in it—an omission not likely to be observed by anyone so confronted, even in fun. Let no such credulity warp your judgment respecting the handling of your critical piping. Remember that Mitchell service speaks with an authority that long *specialized* experience alone can bring to bear on your high-temperature and high-pressure problems.

W. K. MITCHELL & CO., INC.
2946 Ellsworth Street, PHILADELPHIA 46, PA.

WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

ADVERTISERS' INDEX

This index is published as a convenience to the reader. Every care is taken to make it accurate, but PETROLEUM PROCESSING assumes no responsibility for errors or omissions.

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

(A-1) Airetool Mfg. Co. 1306
(A-2) Air Preheater Corp. 1349
(A-3) Air Products, Inc. 1315
(A-4) Aluminum Co. of America, Pigments Div. 1443
(A-5) Aluminum Co. of America, Electrical Prods. Div. 1488
(A-6) American District Steam Co., Inc... 1458
(A-7) Ampco Metal, Inc. 1321
(A-8) American Brass Co. 1324
(A-9) Askania Regulator Co. 1441
(B-1) Atlantic Refining Co. 1328
(B-2) Babcock & Wilcox Co. 1313
(B-3) Badger Mfg. Co. 1316
(B-4) Bethlehem Steel Corp. 1348
(B-5) Black, Sivalls & Bryson, Inc. 1490
(B-6) Brown Fintube Co. 1307
(B-7) Carey Mfg. Co., Philip 1353
(B-8) Catalytic Construction Co. 1336-1337
(B-9) Central Scientific Co. 1343
(C-1) Chicago Bridge & Iron Co. 1330
(C-2) Cities Service Co. 1352
(C-3) Clark Mfg. Co. 1474
(C-4) Cooper-Bessemer Corp. 1323
(C-5) Crane Co. 1378
(C-6) Crawford Fitting Co. 1437
(C-7) Curtin & Co., W. H. 1456
(C-8) Cushman Motor Works 1451
(C-9) Dow Chemical Co. 1470
(D-1) Dowell, Inc. 1312
(D-2) DuPont de Nemours & Co., Inc. 1312A-1312B
(D-3) DuPont de Nemours & Co., Inc. ... 1438
(D-4) Durametallic Corp. 1478
(D-5) Eastern Industries, Inc. 1334
(D-6) Electric Auto-Lite 1478
(D-7) Elect. Controller & Mfg. Co. 1473
(D-8) Enjay, Inc. 1294
Ethyl Corp. 1376-1377
(D-9) Fielden Instrument Div. 1453
(E-1) Flint Steel Corp. 1486
(E-2) Fluor Corp., Ltd. 1314
(E-3) Foster-Wheeler Corp. 1344A-1344B
(E-4) Foxboro Co. 1338
(E-5) Gen'l. Amer. Trans. Co., Terminal Div. 1298
(E-6) Gen'l. Amer. Trans. Co., Wiggins Gasholder Div. 1467
(E-7) Gen'l. Chemical Div., Allied Chem. & Dye Corp. .....Cover 3
(E-8) General Electric Co. 1332-1333
(E-9) Girdler Corp. 1448
(F-1) Glascote Products, Inc., Sub. A. O. Smith Corp. 1331
(F-2) Glitsch & Sons, Inc., F. W. 1485
(F-3) Graver Tank & Mfg. Co., Inc. 1302
(F-4) Harshaw Chemical Co. 1472
(F-5) Hercules Powder Co. 1480
(F-6) Hills-McCanna Co. 1329
(F-7) Homestead Valve Mfg. Co. 1481
(F-8) Hudson Engineering Corp. .....Cover 2
(F-9) International Nickel Co. 1335
(G-1) Johns-Manville Corp. 1477
(G-2) Kaiser Engineers 1447
(G-3) Lincoln-Schlueter Floor Mchy. Co... 1489
(G-4) Lukens Steel Co. 1476
(G-5) Lummus Co. 1301
(G-6) McKee & Co., Arthur G. 1322
(G-7) Midvale Co. 1355
(G-8) Midwest Piping Co. 1444
(G-9) Mitchell & Co., W. K. 1463
(H-1) Mixing Equipment Co. 1356
(H-2) National Lead Co. 1491
(H-3) National Petro-Chemicals Corp. 1457
(H-4) Nicholson & Co., W. H. 1305
(H-5) Nitrogen Div., Allied Chem. & Dye Corp. 1434
(H-6) Nordstrom Valve Div., Rockwell Mfg. Co. 1448A-1448B
(H-7) Norton Co. 1487
(H-8) Oakite Products Co. 1440
(H-9) Ohio Injector Co. 1344
(I-1) Oilwell Supply Co., U. S. Steel 1293
(I-2) Orbit Valve Co. 1350
(I-3) Oronite Chemical Co. 1450
(I-4) Oronite Chemical Co. 1339
(I-5) Palmer Thermometers Inc. 1442
(I-6) Petro-Chem Development Co., Inc. 1320
(I-7) Petreco 1475
(I-8) Pfaudler Co., The 1380
(I-9) Plibrico Co. 1493
(J-1) Pressed Steel Co. 1482
(J-2) Pritchard & Co., J. F. 1469
(J-3) Procon, Inc. 1346-1347
(J-4) Reed Mfg. Co. 1451
(J-5) Reynolds Metals Co. 1471
(J-6) Ridge Tool Co. 1446
(J-7) St. Mary Iron Works 1482
(J-8) Sauerman Brothers 1296
(J-9) Taylor Instruments Co. 1326-1327
(K-1) Tennessee Corp. 1436
(K-2) Tretolite Co. 1342
(K-3) U. S. Gasket Co. 1308
(K-4) U. S. Steel Corp. 1495
(K-5) U. S. Stoneware Co. 1325
(K-6) Universal Oil Products Co. 1318-1319
(K-7) Vogt Machine Co., Henry 1479
(K-8) Vulcan Engineering Div. 1454
(K-9) Warner Lewis Co. 1482
(L-1) Warren Petroleum Corp. 1461
(L-2) Wedgeplug Valve Co. 1345
(L-3) Western Supply Co. 1317
(L-4) Westoil Terminals Co. 1433
(L-5) Wolverine Tube, Div. Calumet & Hecla, Inc. 1483
(L-6) Worthington Corp. 1484
(L-7) Wyatt Metal & Boiler Works ...Cover 4
(L-8) Yarnall-Waring Co. 1494
(L-9) York Co., Inc., Otto H. 1354
(M-1) Zallea Brothers 1351

CLASSIFIED
H. E. Hilty, Mgr.
EMPLOYMENT 1452

WHAT'S NEW . . .

Kit Permits Rapid Inspections Of Pump Parts, Valve Bodies

. . . and welded surfaces for cracks indicative of wear and fatigue. Light in weight and portable, the "Magnaflux Y-5 Yoke Kit" is designed especially for preventive maintenance, weld inspection, and limited volume inspection of magnetic parts. It is said to be very useful in salvage work. The kit comes in a metal carrying case, about the size of a fishing box, and weighs less than 30 lbs., complete. The yoke itself is the magnetizing and testing instrument and weighs 7 lbs. Magnaflux powder, powder bulbs, and operating instructions are included. The yoke is equipped with 100 ft. of cord, and draws only 6 amps from any 110 volt A.C. line. One man performs the inspection by himself. He handles the yoke in one hand, both power control and positioning, and with the other hand he dusts on the powder. The area covered by each application varies up to approximately 24 sq. in. Magnaflux Corp., 7300 West Lawrence Ave., Chicago 31, Ill.

Circle No. **1** *on Reply Card*

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage is required.

New Single-Solution Karl Fischer Reagent Is Stabilized

. . . permitting long storage periods on the shelf. It has been found to maintain its titer within convenient working limits for at least one year, yielding sharp and stable end points in electrometric titrations. It can be opened and placed back on the shelf with little loss in titer. Instead of being packaged in two bottles which must be mixed immediately prior to use, the new reagent comes in a single solution. Each bottle bears a certificate of titer and stability. Catalog No. is So-K-3. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

Circle No. **2** *on Reply Card*

Pulse Code System Telemeters Accurate Liquid Level Readings

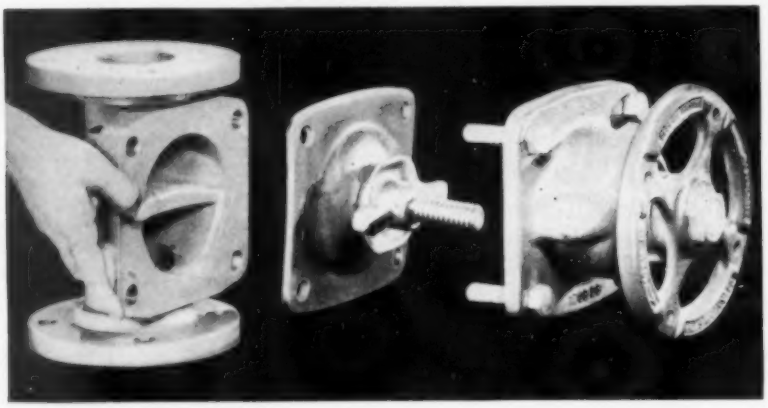
. . . over distances limited only by the availability of communications facilities. The new "Varec" system utilizes a pre-set code for each increment of intelligence to be transmitted. The transmitter portion of the system sets up the code for the particular value of liquid level—say in a petroleum storage tank system—and sends this to the receiver, where the incoming code is translated into the equivalent measurement increment. It can also be applied to other telemetering problems and is particularly adapted to remote supervisory control systems. The receiver output can be fed into printing equipment to provide a permanent record of gage readings, alarm warnings, or other functions sent by the transmitter. Automatic sequencing equipment can be added if desired to provide for fully automatic multiple tank gaging. Transmitters are available in three general types. The Fig. 912, 913, and 914 Series are for use with "Varec" Fig. 253 Series or similar type gages, using ½-in. steel tapes. The Fig. 912 and 913 units are for high pressure service —150 and 300 psi.—they use a magnetic coupling through a solid metal partition between tank side of the unit and the electrical portion. The 914 Series are for low pressure service, up to 30 psi. The 910 Series transmitters are for use with only the Fig. 2500 Series gages. The Vapor Recovery Systems Co., 2820 No. Alameda St., Compton, Calif.

Circle No. **3** *on Reply Card*

Packless Proportioning Pump Provides Pulse-Free Flow

. . . and accuracy of control. Designated the "Hills-McCanna-Meter," the new unit is claimed to meter precisely quantities from 5 cc. to 6 gal./hr., depending somewhat on the material being handled. Under actual operation, the positive displacement pump has handled quantities as low as 3 cc/hr. with good consistency and ability to reproduce the flow. Standard speeds range from 27 to 900 strokes/minute. At higher speeds and capacities, the flow is said to be continuous for all practical purposes. Gases and vapors are vented automatically. Standard units will develop pressures up to 2500 psig. There are no packing glands or stuffing boxes. Pumping unit is sealed and leakproof. Regulation can be adapted to automatic control, utilizing direct instrument air signal. The alloy in contact with fluid being pumped is relatively small and a complete changeover to a different alloy—for handling another fluid for example —can be accomplished at low cost. The unit is also adaptable to ganging in an arrangement wherein additional units are simply connected to the basic unit. Additional motors and speed reducers are not required. Hills-McCanna Co., 3025 North Western Ave., Chicago 18, Ill.

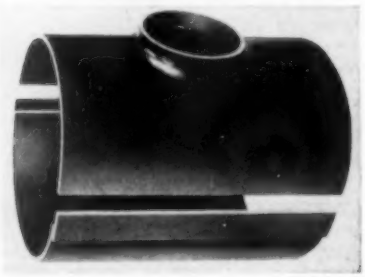
Circle No. **4** *on Reply Card*



New Valve Made of Styrene Polymer

Developed as a component part of piping systems constructed of a styrene polymer called "Uscolite," a new 3-in. all-Uscolite diaphragm valve has been announced. It was a joint-development by United States Rubber Co. and the Hills-McCanna Co. The material has high corrosion-resistance and is non-contaminating in the handling of sensitive chemical solutions and acids. Working pressures range to 150 psi. and temperatures to 170° F. A companion line of 3- and 4-in. pipe fittings of the same material is also available. The valve and fittings are of one-piece, homogeneously molded construction, with no welds or joints at points of stress. U. S. Rubber Co., Rockefeller Center, New York 20, N. Y.

Circle No. **5** *on Reply Card*



"Hot Taps" Are Stronger With New Full Encirclement Saddle

. . . in making branch connections in petroleum processing piping. The new saddle provides a 360° reinforcement, so desirable when dealing with high pressures and large diameter pipe and taps. It meets all requirements for reinforcement of welded branch connections as developed by Section 8 of The Code for Pressure Piping. It is designed for use with either high yield strength thin wall pipe, Grade B 35,000 or 42,000 yield strength pipe, and also heavy wall cylinders such as employed for suction and discharge headers, bottles and pulsation dampeners in compressor stations. It is available in standard and special sizes through 42 in., and in all straight and standard reducing outlet sizes. The saddle is made from rolled plate of the proper chemical composition, mechanical properties and wall thicknesses required for the service conditions encountered. Saddle outlet is forged, and its I.D. corresponds to the O.D. of the branch outlet. The saddle is split longitudinally, on a horizontal plane, perpendicular to the axis of the outlet, thus eliminating welds in the critical crotch area. When clamped to the pipe, the two halves of the saddle are joined firmly by longitudinal straps. If the straps are shop welded to the bottom half, only one field weld on each side is necessary in addition to the weld between the outlet of the saddle and the branch outlet. Tube-Turns, 224 East Broadway, Louisville 1, Ky.

Circle No. **6** *on Reply Card*

Explosion-proof Pedestal Lamp Developed for Refinery Use

. . . and such specific lighting requirements as illuminating fractionating tower catwalks, control board work areas, and the like. The new 200-watt fixture, Type EVPH 4209, is said to exceed Underwriters' Laboratories standards for NEC Class I, Groups C and D hazardous locations. All joints are machined and threaded to a tolerance clearance that allows the entry and consequent internal explosion of volatile mixtures but prevents the effects of such explosions from passing out of the fixture except as cooled exhaust gases. Sealing compounds are not needed. For relamping, the entire fixture is removed as a unit. Removal slots along the main connecting threads of the globe holder assembly enable the threads to be loosened easily by merely prying the slots with a screwdriver. The fixture is for mounting on vertical 1¼-in. conduit. Conduit and hub is provided with eight threads, exceeding NEC requirement of five full threads for Class I locations. Crouse-Hinds Co., Wolf and Seventh North Sts., Syracuse, N. Y.

Circle No. **7** *on Reply Card*

Pure Asbestos Rope Is Useful For Insulating Curved Surfaces

. . . and irregular piping, bends, fittings, valves, expansion joints, and the like. "Caposite" Rope is 100% chemically pure, long-fiber asbestos rovings, twisted together to the correct diameter and retained within a braided reinforcing jacket of asbestos yarn. It contains no organic reinforcing fibers. The material is 50 to 33% lighter than ordinary asbestos rope: heat transfer is correspondingly less: and, size for size, there are two to three times as many lineal feet per pound, the manufacturer states. Insulation effectiveness ranges to 1200° F., and the rope can be removed and re-applied repeatedly at temperatures up to 750° F. Caposite rope is available in 100-ft. coils, in diameters from ½ to 2 in. North American Asbestos Corp., Board of Trade Bldg., Chicago 4, Ill.

Circle No. **8** *on Reply Card*

Only the Wiggins Gasholder*

has the dry fabric seal that

eliminates maintenance problems!

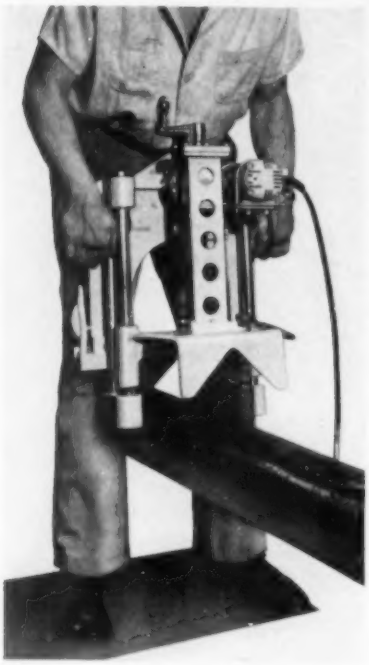
Write for information

WIGGINS VAPOR SEALS GENERAL AMERICAN TRADE MARK

GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South La Salle Street
Chicago 90, Illinois

*PATENTED

 (To obtain more data on advertised products see page 1464)



"Guillotine" Pipe Saw Built For Use in on-the-job Cutting

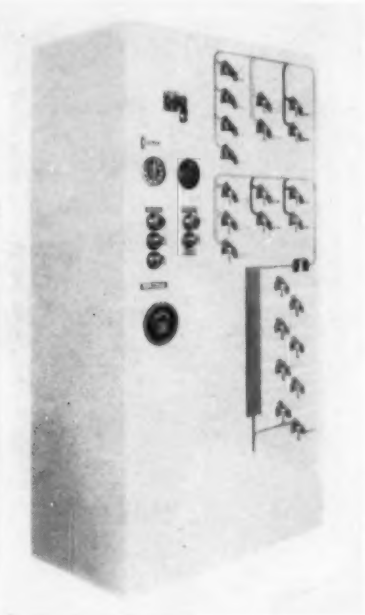
. . . of cast iron and steel pipe in sizes 2, 4, 6, and 8 in. Using either electrical or air power for drive, the machine operates a 12-in. blade over a 2-in. stroke and will work in a space 25 in. wide. A chain pipe vise clamps the portable saw to the pipe in a few seconds. A machined, cast steel, V-base assures a square cut at right angles to the pipe, the pipe itself acting as a machine tool base. Cutting time depends on pipe characteristics: 6-in., standard wall steel pipe can be cut in 8 minutes; the same in cast iron can be cut in 4 minutes. Frame is of aluminum alloy, permitting a total weight of 120 lbs. for ease of handling. E. H. Wachs Co., 1525 No. Dayton St., Chicago 22, Ill.

Circle No. **9** *on Reply Card*

New High Alumina Catalyst Is Developed for Fluid Cracking

. . . and has been subjected to full commercial-scale tests at a major refinery for over a year. Results, according to the manufacturer, have confirmed earlier laboratory indications that it possesses characteristics important to achievement of optimum efficiency. The new product has an alumina content of 25%-wt., as contrasted with the 13% normally used in synthetic catalysts. Test results included a greater stability of catalytic activity, a 15 to 25% higher equilibrium activity, and, in many cases, improved selectivity of end-product distribution. Stack losses also were considerably lower than those ordinarily obtained under comparable operating conditions with the 13%-alumina product. Samples are presently available, and expansion of existing production facilities are expected to make additional commercial quantities soon available. American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y.

Circle No. **10** *on Reply Card*



New Centralized Unit Controls Continuous Polymerization

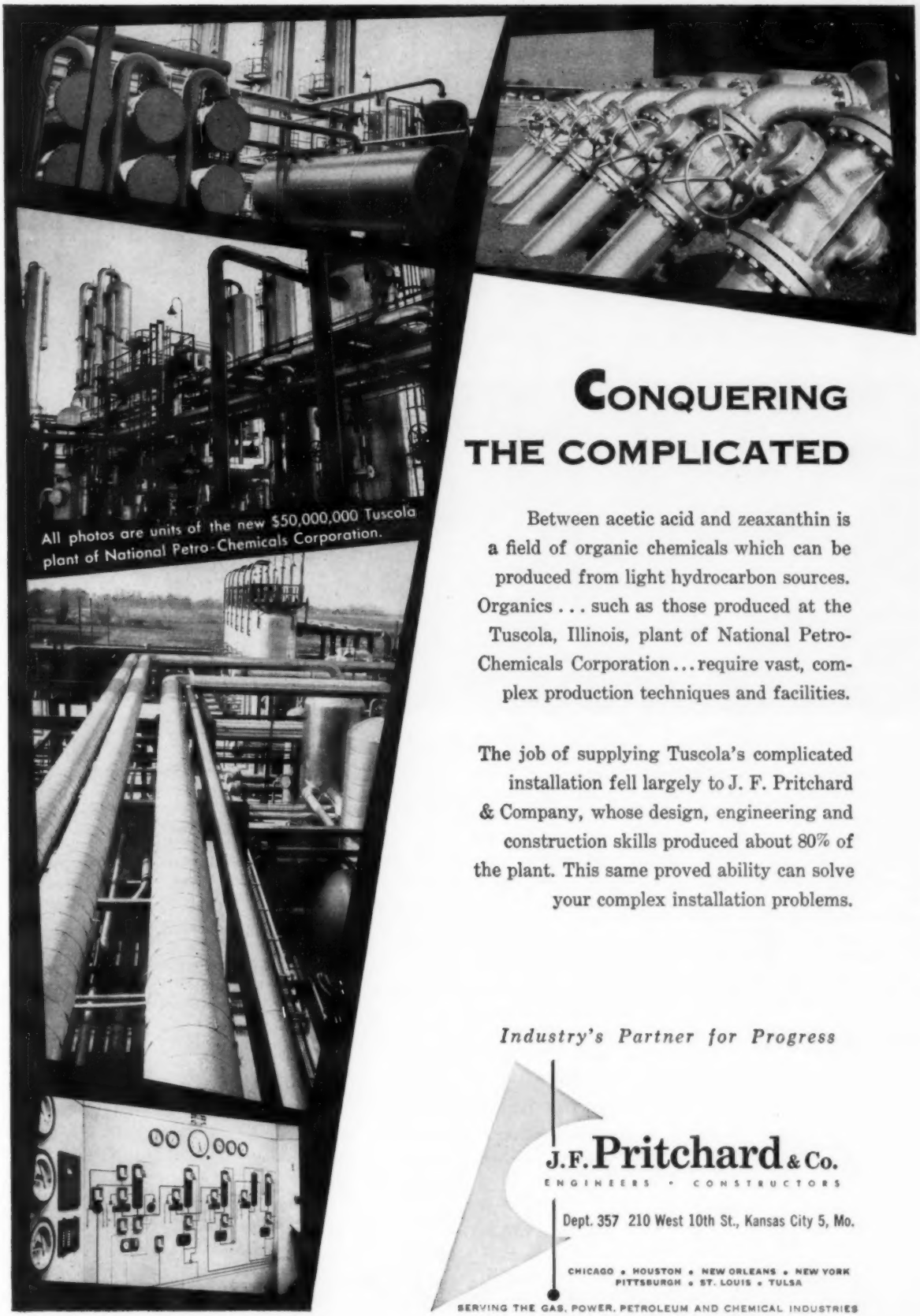
. . . reactors. The complete system provides automatic flow control of feed, catalyst, and product streams and control of reaction temperatures on a graphic panel measuring 3 x 7 ft. The system, using 23 air-operated flow control pumps, was developed to meet four specific requirements: precise proportioning of feed streams, centralized control of all process pumps, independent and automatic control of catalyst feed, and an integral operations monitoring and warning system. Process capacity can be regulated by adjustment of a single control, a large handwheel mounted on the front of the panel which varies pumping rates but maintains pre-set proportions. Any process pump can be cut out of action by switches on the panel. Milton Roy Co., Station V, 1300 East Mermaid Lane, Philadelphia 18, Penna.

Circle No. **11** *on Reply Card*

New "One-Specification" Fitting Covers All Piping Applications

. . . and pressure ratings on pipe connections, according to the manufacturer. It requires no selection of gaskets, facings, or bolts, since all parts are fully interchangeable and reusable. Named the "Graloc," the unit employs a two-bolt clamping principle and a stored energy seal. A steel sealing ring, having flexible lips and a rigid rib, fits between the steel connecting hubs. The angle of the tapered lips of the ring is less than the tapered seats of the hubs. As the joint is made up, the lips of the seal ring conform to the seats of the hubs, thereby utilizing the elasticity of the steel as a source of stored energy to effect and maintain a positive seal. Internal line pressure serves to increase the effectiveness of the seal without creep or movement. The rib of the seal ring affords rigidity, necessary both in handling and in preventing excessive crushing or misalignment during use. Instead of the usual bolting, the Graloc uses a two-piece steel clamp which works against the tapered shoulders on the connecting hubs. The clamp is held in place by two, high-strength steel bolt studs. In a test, a 7 1/16-in. bore connection in a dry nitrogen gas test, stood up to 19,500 psi. and up to 172° F. without leaking. A 2½-in. connection stayed leakproof under an internal pressure of 5000 psi. and a bending moment of 12,800 ft.-lbs. A standard Graloc connection weighs about ½ as much as a comparable 300-lb. flange connection. Outside diameter and length are less than 150-lb. ASA flanges. Connections are made in three styles, butt-welding, slip-on, and threaded, in sizes from 1½ to 12-in., for all standard weights from Sched. 40 through 160 and XX Strong. Gray Tool Co., P. O. Box 2291(B), Houston, Texas.

Circle No. **12** *on Reply Card*



All photos are units of the new $50,000,000 Tuscola plant of National Petro-Chemicals Corporation.

CONQUERING THE COMPLICATED

Between acetic acid and zeaxanthin is a field of organic chemicals which can be produced from light hydrocarbon sources. Organics . . . such as those produced at the Tuscola, Illinois, plant of National Petro-Chemicals Corporation . . . require vast, complex production techniques and facilities.

The job of supplying Tuscola's complicated installation fell largely to J. F. Pritchard & Company, whose design, engineering and construction skills produced about 80% of the plant. This same proved ability can solve your complex installation problems.

Industry's Partner for Progress

J.F. Pritchard & Co.

ENGINEERS • CONSTRUCTORS

Dept. 357 210 West 10th St., Kansas City 5, Mo.

CHICAGO • HOUSTON • NEW ORLEANS • NEW YORK
PITTSBURGH • ST. LOUIS • TULSA

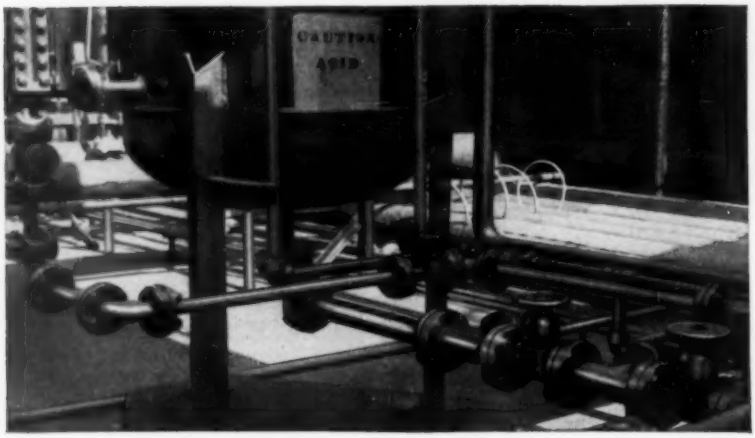
SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

(To obtain more data on advertised products see page 1464)

DOW

CORROSIVE FERRIC CHLORIDE FLOWS THROUGH THIS SARAN LINED INSTALLATION

Large West Coast refinery depends on easy-to-install SARAN LINED STEEL PIPE to resist corrosion and assure uninterrupted processing



Some time ago, a large West Coast oil company investigated better methods to handle corrosive ferric chloride solution. The company's successful operation demands uninterrupted processing. Unscheduled "shut-downs" mean production pile-ups, layoffs and heavy expense. Saran lined steel pipe was successful from the start. The use of saran lined pipe, fittings and valves assured tight, leak-proof joints. The dependable, long-term service and excellent corrosion resistance of strong, rigid saran lined pipe will postpone replacements indefinitely. Saran lined steel pipe can be delivered immediately, cut and threaded to your specifications or fabricated in the field with your own equipment. We'll be glad to assist you with installation plans. THE DOW CHEMICAL COMPANY, Midland, Mich.

Saran Lined Pipe Company
2415 Burdette Ave., Ferndale, Mich.

Please send me a copy of your catalog on saran lined pipe, valves and fittings.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

SP 1167G

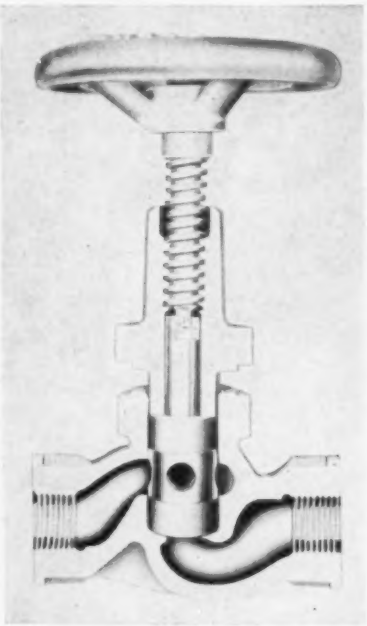
RELATED SARAN PRODUCTS

Saran rubber tank lining • Saran rubber molding stock • Saran pipe and fittings • Saran tubing and fittings

you can depend on DOW PLASTICS

DOW

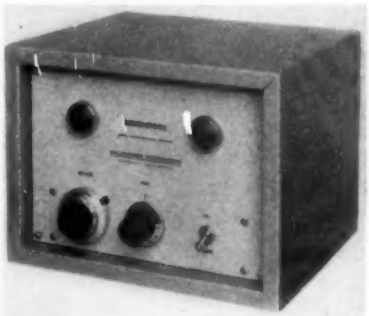
What's New!



Seatless Piston Valve Has Wide Pressure, Temperature Ranges

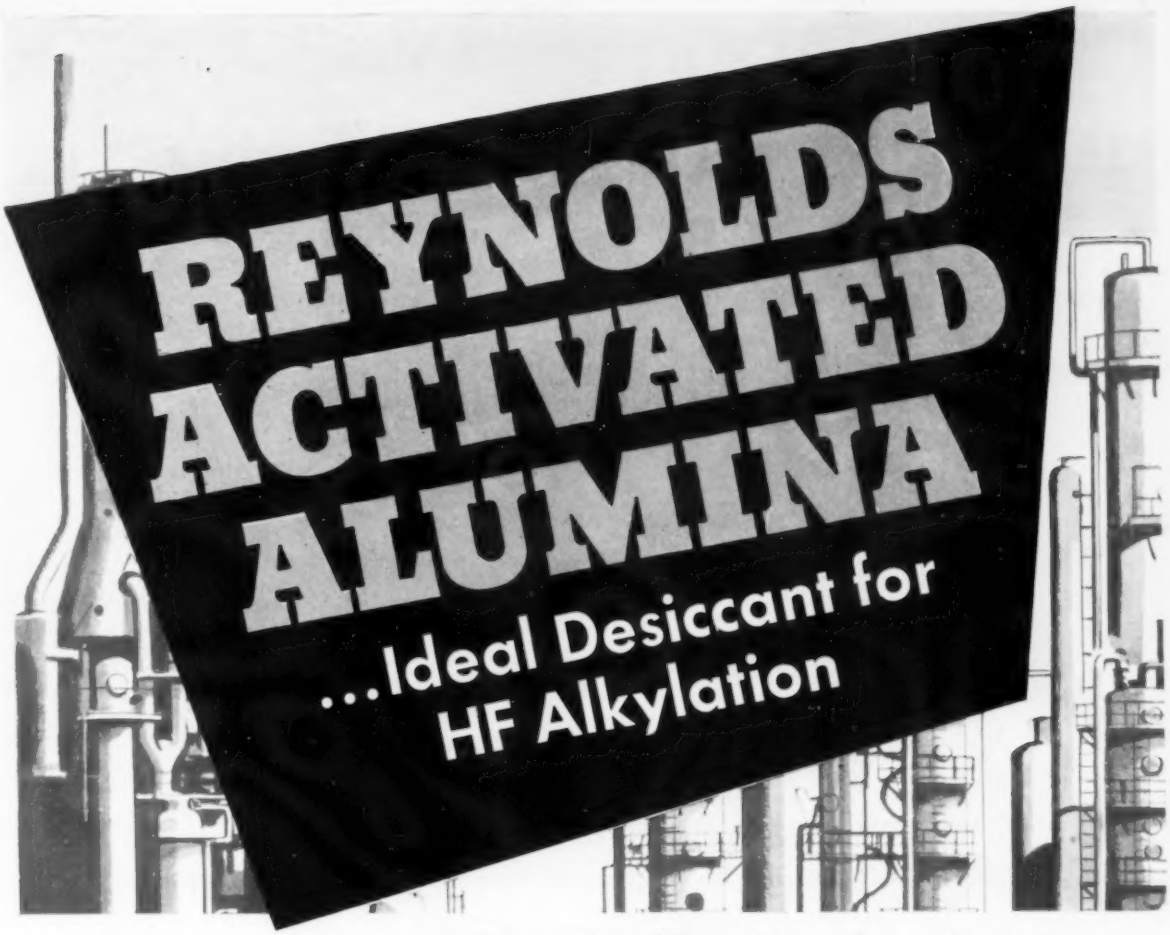
. . . and maintains its pressure tightness by the fit of the piston sliding through two resilient compressed valve rings. Manufacturer states the "Klingerflow" valve has very low maintenance, efficient control of flow, and is unaffected by wire drawing. Valve line is now being manufactured in the United States, along with several other products, including: "Klingerit" asbestos sheet packing, in thicknesses from 0.008 to 0.25 in.; and "T" type water level gages. The Klinger Corp. of America, 95 River St., Hoboken, N. J.

Circle No. **13** *on Reply Card*



Resistance Type Temperature Control Suitable Up to 600 F.

. . . and has a sensitivity, exclusive of bulb, of 0.005° F. The instrument is an AC bridge type. Various type bulbs are available. One is for instal-



REYNOLDS ACTIVATED ALUMINA

...Ideal Desiccant for HF Alkylation

more economical and effective for drying many liquids and gases

The specific advantages of Reynolds Activated Alumina for hydrogen fluoride alkylation are:

- **Elimination of silica migration**
- **Better fluoride removal**
- **Dries alkylate while in process**

Basic product advantages include:

- **Non-reactive with process liquids and gases**
- **Easily regenerated**
- **Low initial cost**
- **Withstands liquid water**
- **Low dewpoint**

Prove these advantages in your drying process. Performance will let you compare the absorptive capacity of Reynolds Activated Alumina against the capacity of other desiccants. Write for free brochure on "*Reynolds Aluminum Chemicals*" to Reynolds Metals Company, 2596 South Third Street, Louisville 1, Kentucky.

Put Reynolds Consulting Service To Work For You

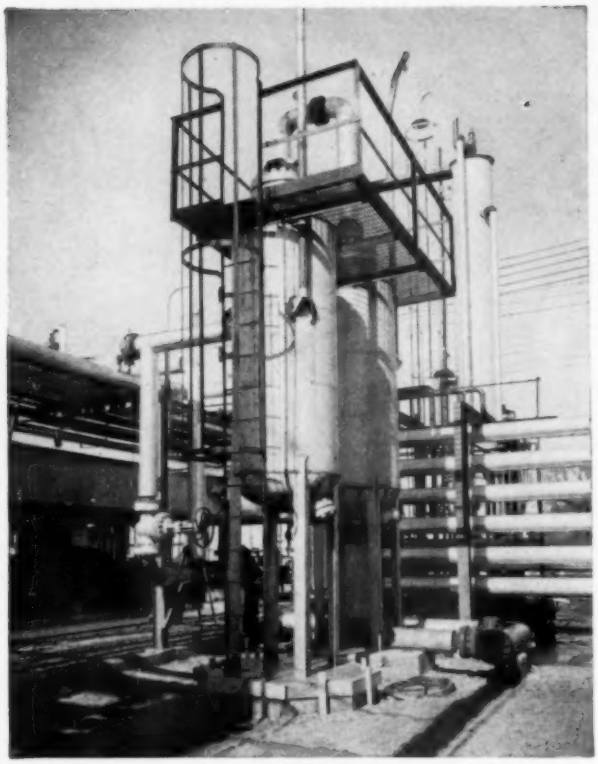
The staff of each Reynolds regional office includes chemical and other engineering specialists to help you save time, money and labor with aluminum chemicals, shipping containers and mill products. When further consultation is desired, there is a fully integrated technical staff at Reynolds headquarters.

See "Mister Peepers" Sundays on NBC-TV. Consult local listings for time and station.

REYNOLDS CHEMICALS

FROM THE PRODUCERS OF REYNOLDS ALUMINUM

INTERESTED IN UNIFINING* FOR DESULFURIZATION AND UPGRADING



• First Commercial Unifining Unit
United Refining Co.
Warren, Pennsylvania

UNIFINING should be of particular interest to all operators of catalytic reformers which produce by-product hydrogen.

• Harshaw is the exclusive producer of the Union Oil Company of California cobalt-molybdate catalyst used in the recently announced "Unifining" desulfurization and upgrading process. This rugged, commercially proven catalyst is supplied in the form of cylindrical tablets conforming to rigid physical and chemical specifications established by Harshaw and Union Oil Company of California. Stability at high temperatures permits repeated regenerations if and when necessary.

Please contact Harshaw for further information on this catalyst.

HARSHAW

THE HARSHAW CHEMICAL CO.

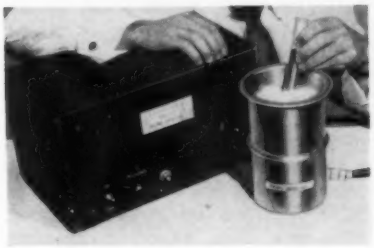
1945 East 97th Street, Cleveland 6, Ohio

Chicago 32, Illinois • Cincinnati 13, Ohio • Detroit 28, Michigan • Houston 11, Texas
Los Angeles 22, California • New York 17, N. Y. • Philadelphia 48, Pennsylvania
Pittsburgh 22, Pennsylvania

* Trademark of Union Oil Company of California

lation in pressure vessels and another for atmospheric pressures. The standard bulb has a time constant of 4 seconds; however, for greater sensitivities, faster response bulbs or thermistors are available for the new "Resistotrol" temperature controller. Hallikainen Instruments, Inc., 1341 Seventh Street, Berkeley, Calif.

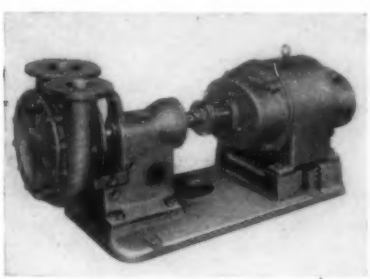
Circle No. **14** *on Reply Card*



Ultrasonics Used to Clean Small, Complex, and Delicate Parts

. . . such as instrument components, vacuum tube elements, miniature machined parts, and microchemical glassware. The Model 50 Series "Liquid Load Ultrasonic Generator" employs a barium titanate transducer, resonant at a frequency of about one megacycle, driven by a 50-watt, RF generator. It radiates mechanical vibrations into a quart-size container of cleaning solvent or, if desired for laboratory experimentation, into a liquid sample in a test tube. When used for cleaning purposes, it will handle parts to a maximum dimension of 4 in. Grease, coatings, solder, dirt, and other particles are vibrated from inaccessible surfaces, crevices, thin bores, and the like. The container is made of stainless steel. Unit operates on 110 volt, 60 cycle A.C., and can be placed on a bench top. McKenna Laboratories, 2503 Main St., Santa Monica, Calif.

Circle No. **15** *on Reply Card*



Line of Centrifugal Pumps Is Designed for Corrosive Liquids

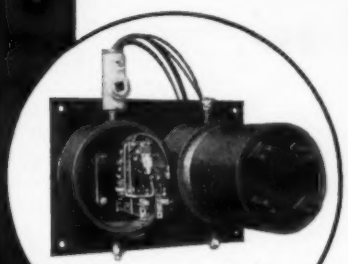
. . . and slurries. Designated as the Fig. 3715 series, they are available

OIL MEN Specify:

2200-5000 Volts

EC&M

50,000 KVA
Interrupting Capacity
MOTOR STARTERS



Enclosing covers on Overload Relays screwed on . . . give quick access.

OUTSTANDING ADVANTAGES

1. Reduced floor space
2. Low-cost Div. 2 design
3. 50,000 KVA interrupting capacity
4. Combination starter with Disconnect Switches
5. Corrosion resistant, weatherproof construction
6. Copper tungsten contacts for positive operation
7. Simple 3-wire TIME-DELAY UVP push button circuit
8. THERMAL-MAGNETIC Overload Relays give accurate motor protection . . . trip instantly on faults
9. All internal wiring complete

1914

Petroleum engineers specify these starters for Division 2 semi-hazardous locations because they assure substantial savings in installation and operation.

Construction advantages include: drip-proof roof . . . tank-cover and front cubicle doors . . . oil switch which opens 220-volt control transformer before upper door can be opened to operate main line disconnects . . . hermetically sealed control circuit contacts . . . main contactor with alloy contacts oil-immersed in rear tank. On voltage dips, push button circuit maintained up to 2 seconds by simple 3-wire circuit, permits opening of "stop" circuit without delay.

EC&M 2200-5000 volt Starters are also available in Division 1 style for Class 1, Group D Hazardous Locations. For interrupting capacities above 50,000 KVA, EC&M VALIMITOR (volt-ampere-limitor) Starters are furnished in both Division 1 and Division 2 construction.

Write for 16-page Booklet 1062 for complete details.

THE ELECTRIC CONTROLLER & MFG. COMPANY

2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Trapping Methods Inefficient?

Switch to Clark DUO-STEP Leverage

Exhaustive tests prove that Clark Duo-Step Steam Traps boost trapping efficiency over 100% beyond the drainage capacity engineers have come to expect from ordinary old-fashioned steam traps.

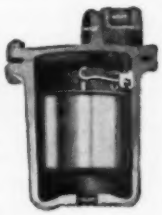
By using the patented double fulcrum principle, Clark Duo-Step Traps can handle *twice* the usual volume of condensate and can save you money on both the original purchase and upkeep.

Give Clark Duo-Step Steam Traps a trial on your steam lines and learn about true steam trap efficiency.

Write, wire or phone for the name of our nearest representative.

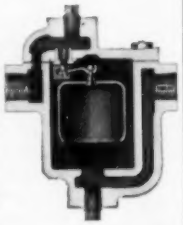
CLARK "701"-D (DUO-STEP) TRAP. A forged steel trap for pressures up to 500 P.S.I. and temperatures of 750°F. Equipped with "double-drainage" Duo-Step Leverage and Venting, Clark-loy seats and discs. Pipe sizes ½" or ¾".

SERIES "80"-D (DUO-STEP) TRAPS. Cast semi-steel construction for pressures up to 250 P.S.I. and temperatures to 450°F. Equipped with Duo-Step Leverage and Venting, Clark-loy seats and discs. Pipe sizes from ½" to 2".



"Y" SELF-CLEANING STRAINERS. Remove dirt, scale and grit from steam, fluid and gas lines. Sizes ½" to 3" I.P.S.

CLARK "60-D" (DUO-STEP) TRAP. Cast semi-steel construction, designed for pressures up to 200 P. S. I., temperatures to 400°F. Duo-Step levers and brackets of stainless steel construction. Seats and discs are of Clark-loy. ½"or ¾" horizontal inlet and outlet connections with ¼" test outlet and drain plug. Vertical inlet can be furnished in ½" or ¾" size.



THE HOME OF DUO-STEP LEVERAGE

Clark

MANUFACTURING COMPANY

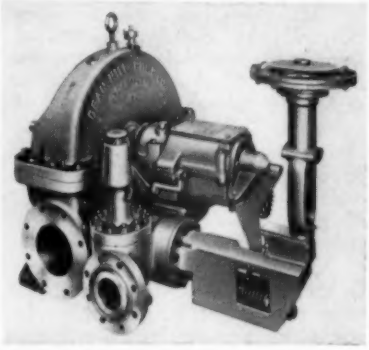
1830 EAST 38th STREET

CLEVELAND 14, OHIO

Distributors and Representatives in all major cities

with the entire fluid end in Type 316, "Gould-A-Loy 20," or Type 304 stainless steel, all iron, all bronze, bronze-fitted, all iron with stainless trim, or all bronze with stainless trim. Gould-A-Loy 20 is a ferrous alloy, bearing the ACI designation CN-7MCU. Maximum liquid temperature limitation is 350° F., with provisions for water-cooling of the support head and quenching of the gland. Single or double mechanical seals can be provided, and they also can be quenched. Stuffing box is on suction side of impeller, so it is under suction pressure only, assuring long packing life, and reducing leakage. Impeller is of the semi-open type, and clearance between vanes and casing can be adjusted externally with no dismantling Nine sizes are being built, ranging from ¾ to 3 in., providing capacities up to 720 gpm. and heads to 200 ft. Goulds Pumps, Inc., Dept. OP, Seneca Falls, N. Y.

Circle No. **16** *on Reply Card*



Pressure Regulators Designed For Feed Water Applications

. . . requiring precise and automatic control. They can be used with any of the manufacturer's turbine models of either horizontal or vertical design. They are furnished with direct-acting or remote control, and can be arranged to maintain a constant pump discharge pressure, or constant differential pressure over boiler pressure. The regulator controls all turbine speeds up to normal rating, but above this point the turbine governor over-rides the regulator to prevent overspeeding. The emergency trip valve remains independent. To effect maximum efficiency of control and to eliminate lost motion and deflection, the regulator is mounted on a rugged support made of welded six-inch channels. Dean Hill Pump Co., Dept. 9, 4000 East 16th St., Indianapolis 7, Ind.

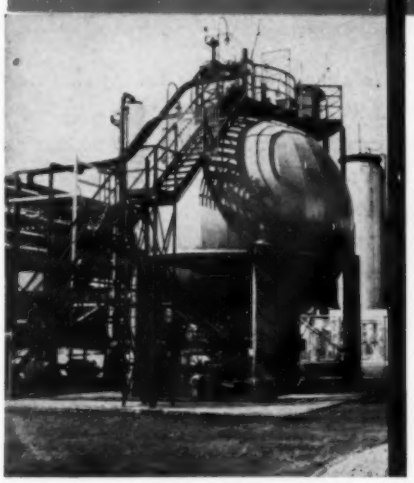
Circle No. **17** *on Reply Card*

24 REFINERS INCREASE DAILY THROUGHPUT WITH PETRECO DESALTING

In one refinery after another, Petreco desalting has promoted operational savings. The resulting fast "pay outs" have rendered the cost of the desalting installation virtually incidental. These fast pay outs result from one basic factor – *Petreco desalting enables the refinery to run more crude.*

The table below shows typical results of Petreco desalting in twenty-four refineries recently surveyed. These refineries charge a wide variety of crudes. Note the barrels of crude run per day – before, and after, desalting. Note the number of days on stream – before, and after, desalting. Note the percent increase in throughput. Why not have these benefits in your refinery? They easily pay for the cost of desalting, and result in substantially more profitable operations.

No.	TYPE OF CRUDE	GRAV. °API	BBLS. PER CAL. DAY		% INCREASE	NO. OF DAYS ON STREAM	
			BEFORE DESALTING	AFTER DESALTING		BEFORE DESALTING	AFTER DESALTING
1	OKLA. ASPHALT	16	950	1,900	100.0	1	75
2	TALCO, WINNSBORO	21	10,500	14,000	33.0	14	360
3	STEPHENS, ARK.	29	1,200	2,000	66.6	10	90
4	SO. LA. SWEET	38	11,000	13,000	18.2	100	125
5	NO. TEXAS SWEET	37	6,760	7,540	11.5	26	78
6	KANSAS SWEET	30+	3,360	3,820	13.7	37	125
7	MICHIGAN LIGHT	44	3,000	4,000	33.3	18	180
8	MIXED CRUDES	16-38	13,000	17,000	30.8	90	180
9	NO. TEXAS-OKLA.	40	8,000	10,000	25.0	33	145
10	GULF COAST	33	15,000	17,500	16.7	..	..
11	WEST TEXAS, SOUR	32	3,900	4,900	25.5	30	180
12	OKLAHOMA, SOUR	20	1,960	2,840	45.0	30	90
13	SHULER, ARK.	33	15,800	18,000	14.0	7	150
14	NEW MEXICO, SOUR	35	1,350	2,150	59.0	..	..
15	WEST TEXAS, SOUR	34	1,000	2,500	150.0	10	40
16	MICHIGAN	38	2,800	3,500	25.0	2	60
17	HASTINGS, SO. TEXAS	31	31,102	41,184	32.4	29	65
18	NO. TEXAS, OKLA.	40	4,000	4,940	23.5	90	180
19	MID CONTINENT	37	4,450	4,950	11.2	45	225
20	RANGER, NO. TEXAS	41	6,000	8,000	33.3	..	..
21	WEST BRANCH, MICH.	33	1,500	3,000	100.0	4	30
22	MICHIGAN	37	14,300	22,100	54.5	..	..
23	SANTA MARIA	14	2,200	2,700	22.7	60	365
24	WEST TEXAS, SOUR	33	1,850	2,750	48.5	90	366



For complete information write or call

PETRECO

A DIVISION OF PETROLITE CORPORATION

3202 South Wayside Drive, Houston 1, Texas

1390 East Burnett Street, Long Beach 6, California

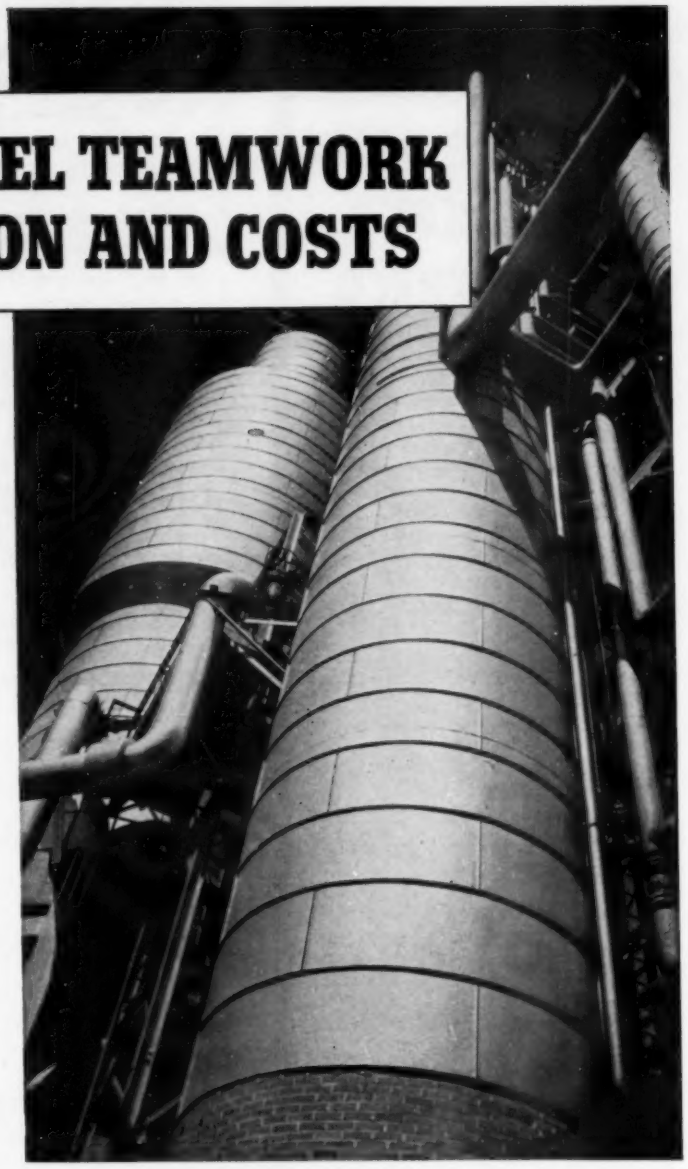
ELECTRIC PETROLEUM PROCESSING

DESALTING • DEHYDRATING • SEDIMENT SEPARATING

DISTILLATE TREATING • DESAPONIFYING

(To obtain more data on advertised products see page 1464)

HOW CLAD STEEL TEAMWORK CUTS CORROSION AND COSTS



Two clad steels combine specialized talents to lick corrosion in this 20,000-barrel-per-day refinery unit

Selecting material for this two-stage refinery unit was a double-tough problem. The upper section of the atmospheric tower had to withstand the corrosive action of condensing mineral acids and organic chlorides . . . the lower part had to handle corrosive asphalt crude containing up to 2.50% sulphur concentrations. The vacuum still had to process a lube cut at 750°F. The equipment builder solved the corrosion problem *economically* by teaming up two clad steels: Monel-clad for the upper part and stainless-clad for the lower part of the atmospheric tower, and stainless-clad throughout the vacuum still.

With economical clad steel—a layer of solid high alloy permanently bonded over its entire surface to a low-cost carbon-steel backing plate—there is no possibility of seepage or crevice corrosion . . . no costly maintenance or downtime . . . no equipment failure. In addition, clad steels assure resistance to thermal shock, flexible efficient operation, low first cost and easy economical field erection.

Equipment values like these also result from another kind of teamwork. Sound engineering and modern fabricating techniques can take advantage of the versatility of clad steels. You will find that it pays to consult your fabricators *early* in your planning for tanks and pressure vessels. They can work with your engineers and consultants, translate ideas into the specialized equipment you require.

Ask one of your fabricators to show you the new Lukens clad steel movie, "Equip for New Profits." Here—in full color and sound—are factual accounts of how clad steel equipment brings new economies. The story can suggest new ideas to everyone concerned with production efficiency. Or contact Manager, Marketing Service, Lukens Steel Company, 682 Lukens Building, Coatesville, Pennsylvania.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEELS AVAILABLE ANYWHERE

New "Trickle" Valve Designed As Dip-Leg Seal for "Cat" Unit

. . . permitting instant attainment of operating conditions with a minimum loss of catalyst. A free-swinging ring-type hinge assures true alignment of surfaces affecting the gas seal, and offers no resistance to movement of the valve plate by the returning catalyst. The Ducon Co., Mineola, L. I., N. Y.

Circle No. **18** *on Reply Card*

Trade Literature

Pneumatic Controllers

. . . for process variables, such as flow rate, liquid level, viscosity, pressure, temperature, vacuum, differential pressure, and motion; *Catalog 53-10* describes possible applications and adaptations, has schematic operation diagrams. Fischer & Porter Co., 148 Jacksonville Rd., Hatboro, Pa.

Circle No. **19** *on Reply Card*

Instrumentation

. . . activities of the company are described in a new 21-page brochure, "Greater Profits Through Consolidated Instrumentation"; illustrations and details are provided of work done for industry and government. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle No. **20** *on Reply Card*

J-M BLAZECRETE speeds refractory repairs...

That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

REPAIR old refractory linings—or build new ones—quickly and economically with Blazecrete*. For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place.

When gunned, it adheres readily with a minimum of rebound loss. Either way, Blazecrete goes on fast . . . without laborious ramming or tamping. *And Blazecrete linings last.*

Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix . . . can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

STANDARD BLAZECRETE—For temperatures through 2400F. Makes repair work easier and less costly. Can be used by boiler manufacturers to replace fire clay tile in wall construction. Suitable for use in combination with 3X Blazecrete and L. W. Blazecrete.

L. W. BLAZECRETE—For temperatures through 2000F. An insulating refractory . . . light in weight, low in thermal conductivity. Adaptable and economical for many other applications.

Send for Brochure RC-28A on Blazecrete and its companion material, Firecrete*. . . the hydraulic setting castable refractory for making special shapes and linings. Write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Reg. U.S. Pat. Off.

Whether you gun it... *or slap-trowel it...*

Johns-Manville **BLAZECRETE**

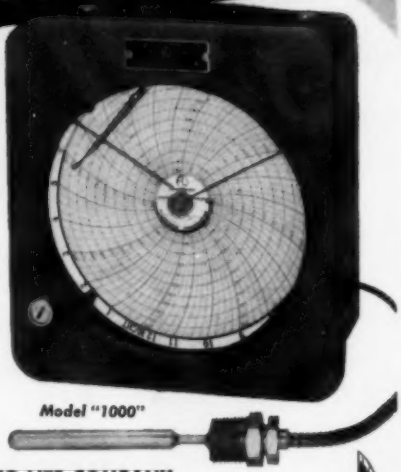
BUILDS BETTER REFRACTORY LININGS

AUTO-LITE

TEMPERATURE RECORDING...

Newly designed, Model "1000" Auto-Lite Recorder gives permanent proof of temperature behavior. • 6" clear reading chart; various standard ranges from minus 40°F. to plus 550°F. • 3 standard types; choice of 24-hr. or 7-day cycle. • Electric or mechanical chart drive. • With capillary tubing for remote reading. Priced from $49.50.

Send for new catalog describing many styles of Auto-Lite temperature Recorders and Indicators.

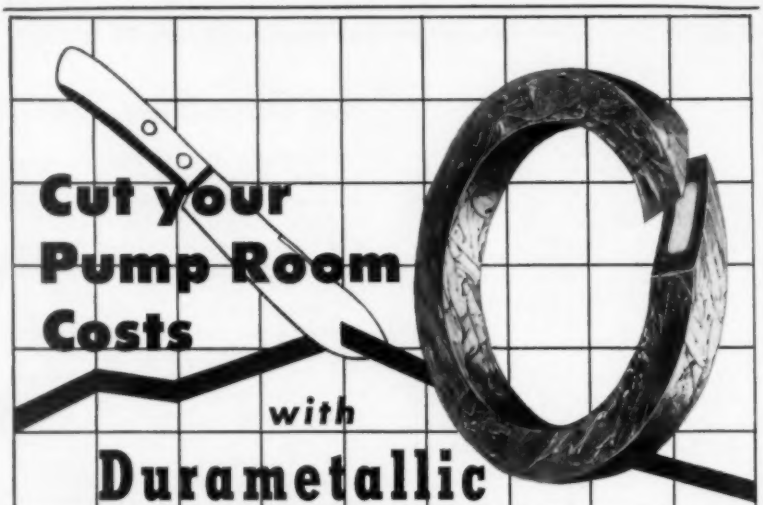


Model "1000"

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS

Cut your Pump Room Costs with Duralmetallic "Engineered For The Job" Packings



Write today for FILE No. DMPP describing the complete line of Durametallic wear-free packings.

The PERFECT SEAL

DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

MANUFACTURERS OF METALLIC and SEMI-METALLIC PACKINGS
ROTARY MECHANICAL SEALS and PACKING TOOLS

What's New!

Succinonitrile

. . . its organic reactions, properties, and potential uses are the subject of *Technical Bulletin O-116;* reactions diagrammed include those of both the nitrile and methylene groups; a possible application is as an absorbent for countercurrent extraction of polar compounds from hydrocarbon solutions. Monsanto Chemical Co., 1700 S. Second St., St. Louis 4, Mo.

Circle No. **21** *on Reply Card*

Continuous Mass Spectrometer

. . . that will analyze one or more components of a process stream; *bulletin CEC-1824A* has diagram of unit's operation, schematic diagram of complete set-up, photos and details of accessories, application information, performance characteristics. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle No. **22** *on Reply Card*

End-Suction Pump

. . . centrifugal, with capacities up to 1000 gpm.; *Bulletin* 4011 describes line of end-suction pumps as well as optional features for specific needs—special impeller for liquids containing solids, liquid end assembly of corrosion-resistant metals where necessary, etc.; performance curves and tables given for work at 1750 and 3500 rpm. Deming Co., Salem, Ohio.

Circle No. **23** *on Reply Card*

Steam, Liquid Controls

. . . including pressure and temperature regulators, and valves of all kinds—relief, diaphragm, motor operated, solenoid, etc.; *Catalog No.* 54 gives specifications on all products, as well as quick reference tables on pressures and temperatures, water heads and equivalent pressures, and flanges. O. C. Keckley Co., 400 W. Madison St., Chicago 6, Ill.

Circle No. **24** *on Reply Card*

Chemical Porcelain Equipment

. . . for process applications; *Bulletin* 438 contains data on "Y" and angle valves, safety valves, plug cocks, pipe and fittings, towers, tower plates and nozzles and Raschig rings, as well as new kinds of valve packings and a new armoring for porcelain; also, installation and operating recommendations. Lapp Insulator Co., Le Roy, N. Y.

Circle No. **25** *on Reply Card*

KING SIZE

This giant 37 ton Cat Poly Reactor is one of 4 units shipped to a large petroleum refinery in the State of Washington. It is 4'-3½" in diameter by 32'-0" long and has a 1 3/16" thick shell. Each of its 8" thick heads is attached to the shell channel with 28 special alloy stud bolts 2¾" diameter by 15¼" long having nuts 4¼" across the flats. Into the 5¾" thick tube sheets 190 tubes, 2½" O. D., No. 5 gauge and 30'-0" long, are rolled and seal welded. Designed for 1,230 lbs. pressure on the tube side, the reactor was completely X-rayed and stress relieved.

Vogt, a leading builder of shell and tube reactors for poly plants, has the competently skilled personnel and modern mechanical facilities with which to provide heat transfer equipment for the most exacting services in petroleum refineries, chemical plants, and related industries.

Reactors ...by Vogt

A bulletin describing the wide range of heat transfer equipment built by Vogt is available upon request.

HENRY VOGT MACHINE CO., LOUISVILLE, KENTUCKY

BRANCH OFFICES: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

POLYRAD CONTROLS CORROSION REGARDLESS OF pH

Specifically developed to control corrosion at low pH, Polyrad is a highly effective inhibitor over the entire pH range encountered in refinery operations. For example, in strong acids, such as HCL with pH under 0.1, Polyrad provides more than 98 per cent protection at temperatures as high as 180°F.

Polyrad, a filming amine inhibitor developed through Hercules research, forms a protective molecular film to shield refinery equipment from hydrogen-ion attack by organic and inorganic acids. From crude units to gas plant areas, Polyrad helps maintain throughput, increases heat transfer, reduces metal loss, and cuts down time for maintenance.

A plus feature of Polyrad is its detergent action which loosens iron sulfide and other scales so the fluid stream can remove them from process equipment.

Polyrad is quickly available from conveniently situated stocks. We would like to work with you in evaluating it under your specific operating conditions. As a preliminary step, write Hercules for descriptive brochure.

Naval Stores Department

HERCULES POWDER COMPANY

INCORPORATED

984 King St., Wilmington 99, Del.

POLYRAD®

FILMING AMINE INHIBITOR

What's New!

Dall Flow Tube

. . . a primary metering device of British invention now being manufactured by an American company for the domestic market; said to have the lowest permanent head loss of any known type of velocity-increasing differential producer; 16-page *Technical Bulletin 115-L3* has engineering information, tables and graphs for selection of proper tube and secondary instruments. Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle No. **26** *on Reply Card*

Propylene Oxide

. . . useful as an intermediate for petroleum de-emulsifiers and applications in other industries; *F-8485* is a technical information sheet giving physical properties, specifications, shipping data, constant-boiling mixtures, physiological properties, and application information. Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17.

Circle No. **27** *on Reply Card*

Cast Alloy Data Sheets

. . . collected in booklet; chemical composition, mechanical and physical properties, resistance to major corrosive solutions, machinability, heat treatment and weldability are given for each alloy; also, equivalent designations of ACI, AISI, SAE and ASTM included. Cooper Alloy Foundry Co., Hillside, N. J.

Circle No. **28** *on Reply Card*

Rigid Plastic Pipe

. . . extruded from a special formulation of polyvinyl chloride resin and capable of being used with pressures to 239 psi.; said to be highly inert, non-corrosive, easily workable; *Pipe Application Folder* contains information on pipe's structural advantages, gives physical properties, specifications and prices, and fitting dimensions. Clopipe Division, Clopay Corp., Cincinnati 14, Ohio.

Circle No. **29** *on Reply Card*

Flange Surface Finishes

. . . and their effect on gasket sealing and joint performance; *The Gasket, Vol. 1, No. 7,* outlines experimental work done with different machined flange surface finishes and the results; gives a list of recommendations of the best finishes for different gaskets. Johns-Manville, 22 E. 40th St., New York 16.

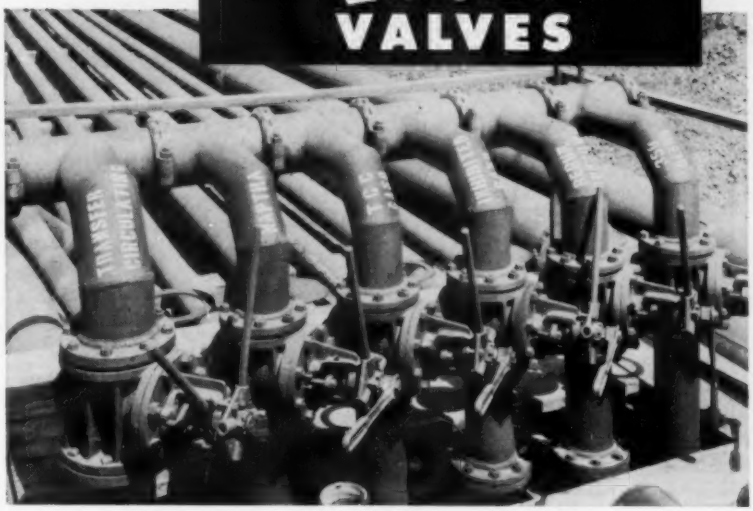
Circle No. **30** *on Reply Card*

★ positive, DROP-TIGHT shut-off

★ instant STICK-PROOF operation

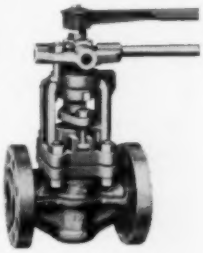
"built-in features of"

HOMESTEAD
Lever-Seald
VALVES



Built right into every HOMESTEAD LEVER-SEALD VALVE is a powerful lever-and-screw device that either firmly seats the valve, or relieves seating pressure just enough to overcome friction and permit easy operation. For this reason, hard-to-hold fluids or extremes of temperature and pressure cannot cause a HOMESTEAD LEVER-SEALD VALVE to stick or "seize."

Instant, dependable operation, long service life, and extremely low maintenance cost are assured by this exclusive HOMESTEAD design. All vital operating parts and seating surfaces are protected from the corrosive or erosive effects of line fluids. No lubrication is required, but valve may be pressure gun lubricated if desired.



HOMESTEAD LEVER-SEALD VALVES are available in metals and alloys to specification; sizes 1½" to 12"; from vacuum to 1500 lbs.; temperatures from 40° below zero to 1100° F.

For complete details MAIL THE COUPON TODAY.

Without obligation, send me Catalog 39-3 covering Homestead Lever-Seald Valves.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

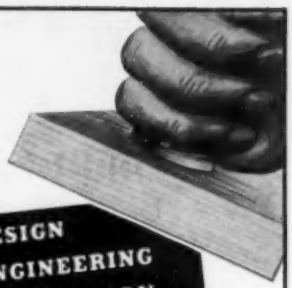
HOMESTEAD VALVE MANUFACTURING COMPANY
"Serving Since 1892"

P. O. BOX 43 CORAOPOLIS, PA.

STAMP OF SUPERIORITY

in the

Petroleum Industry



- ☑ DESIGN
- ☑ ENGINEERING
- ☑ FABRICATION

BY ST MARY IRON WORKS

Special facilities for **DESIGN, ENGINEERING** and **FABRICATION** of **Barges . . Tanks . . Steel Buildings**

Write, Wire or Phone

ST. MARY IRON WORKS

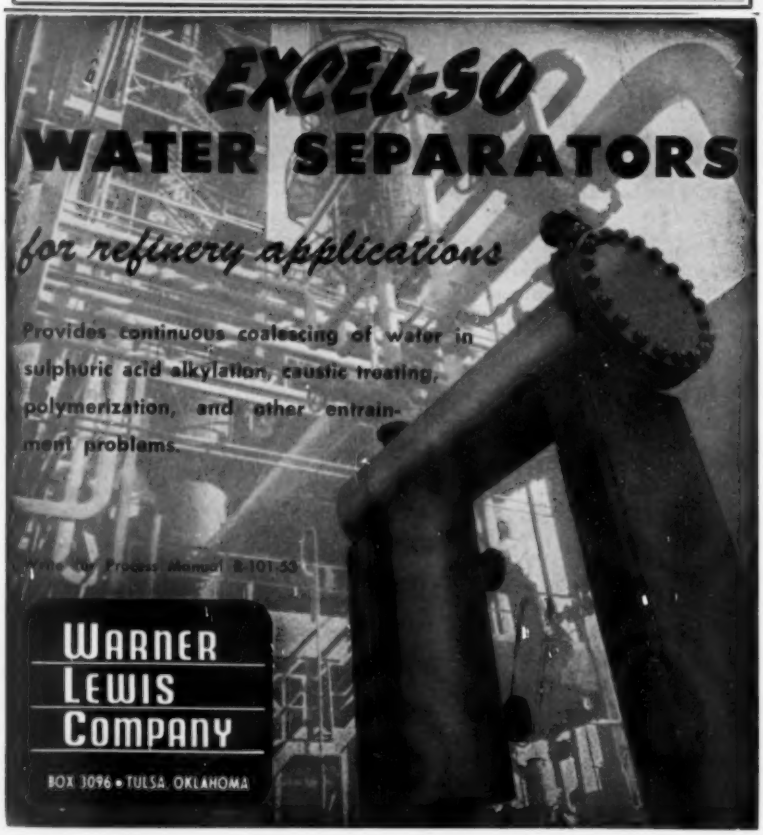
Steel Fabrication for Half A Century

FRANKLIN, LOUISIANA U. S. A.

INTERESTED IN PETROCHEMICALS?

Don't miss pp. 1379 through 1432 in this issue. You can get a free reprint of the 1954 Directory of Petrochemical Plants in the U. S. and Canada (pp. 1417-1432) by writing to:

PETROLEUM PROCESSING
Reader's Service Department
330 West 42nd Street, New York 36, N. Y.


EXCEL-SO
WATER SEPARATORS
for refinery applications
Provides continuous coalescing of water in sulphuric acid alkylation, caustic treating, polymerization, and other entrainment problems.
Write for Process Manual B-101-53
WARNER LEWIS COMPANY
BOX 3096 • TULSA, OKLAHOMA

What's New!

"Packaged" Boilers

. . . oil or gas-burning, for capacities from 4100 to 30,000 lbs. of steam an hour at pressures up to 250 psig.; *Brochure WT-7* lists design advantages, gives specifications for the company's three types of boiler. Wm. Bros Boiler Mfg. Co., 1057 Tenth Ave. S.E., Minneapolis 14, Minn.

Circle No. **31** *on Reply Card*

Diaphragm Valves

. . . made of "Permanite," a furan resin said to be exceptionally resistant to corrosion, with a diaphragm of rubber, Neoprene or Teflon; *Bulletin No. 15* contains a construction diagram, picture of valve, and details. Maurice A. Knight, Akron 9, Ohio.

Circle No. **32** *on Reply Card*

Coke Handling and Storage

. . . is fully discussed in a new 24-page brochure, *Materials Machines & Motions, Coke,* illustrating and explaining equipment for this operation and its installation at several refineries. Sauerman Bros., Inc., 522 So. Clinton St., Chicago 7, Ill.

Circle No. **33** *on Reply Card*

Chemical Feeder

. . . that will meter, control, mix and dispense small proportions of liquid chemicals into liquid streams; *Catalog 70-50* has cross-section diagrams and schematic flow diagrams, specifications and a list of applications. Fischer & Porter Co., 149 Jacksonville Rd., Hatboro, Pa.

Circle No. **34** *on Reply Card*

Swing Joints

. . . 35 styles of bronze or steel, plain or flanged; *Catalog F-8* has drawings of each style, dimension diagrams, information about replacement parts, service instructions. OPW Corp., 2735 Colerain Ave., Cincinnati 25, Ohio.

Circle No. **35** *on Reply Card*

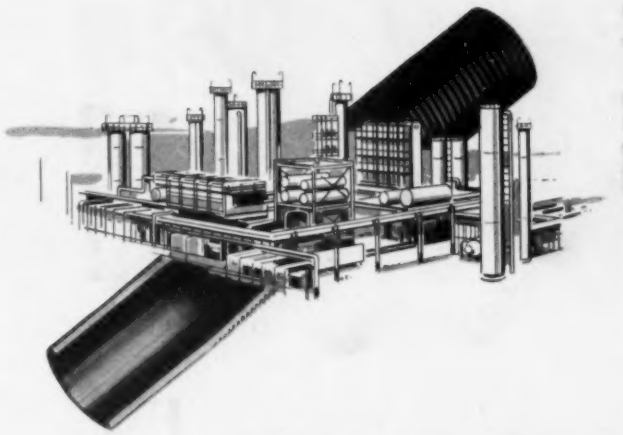
Centrifugal Acid Pump

. . . without a stuffing box, company's improved type "RE"; bulletin describes advantages, shows cross-section drawing. Rheinhuette, Wiesbaden-Biebrich, Germany. American representatives: Neumann and Welchman, Inc., 22-12 Raphael St., Fair Lawn, N. J.

Circle No. **36** *on Reply Card*

47% INCREASE IN BTU's PER HOUR

Heat Exchange Capacity Stepped Up by Wolverine Trufin* Type S/T Condenser Tubing



Look at the chart in the next column. It graphically compares two condensers identical in size used for condensing Freon 12 with water. One condenser is tubed with prime surface tube, the other with Wolverine Trufin, Type S/T. BTU's per hour soar from 390,000 to 575,000—an increase of 47%!

• • • •

This is proof positive of the economies awaiting those engineers who insist on Trufin for shell and tube heat exchangers. Not only do you boost capacity—get more BTU's per foot of tube—but you get more "in line" service as well. Because the fins of Trufin are integral—extruded from the tube wall—they can't shake loose as a result of vibration, pressures, or temperature changes.

Unusual? No! This is just another example of the type of service given every day by Trufin. While this is a specific application, the same benefits apply to other types of hydrocarbon condensers. It could be in any refinery or petro-chemical plant—maybe yours!

Trufin is available in copper (and its alloys), aluminum, electric-welded steel, and bimetal. You can get similar case histories—more pertinent data—if you write for Wolverine's new "Opportunity" Booklet. It's yours for the asking!

*REG. U.S. PATENT OFFICE

Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario.

	PLAIN TUBE	TRUFIN TYPE S/T
Shell Size, O.D.	12¾"	12"
Tube Length	7'	7'
Tube Specification	⅝" OD—18BWG 90-10 Cu. Ni.	⅝" OD—18BWG 90-10 Cu. Ni. Trufin Type S/T
Outside Surface Sq. Ft.	143.34	334.0
No. of Tube Passes	4	2
On the basis equivalent water flow Water Flow USGPM	102.0	107.2
Water Velocity, FPS	4.68	3.32
Heat Load BTU/(Hr.)	411,000	652,000
U_d, BTU/(Hr.) (°F) (Sq. Ft.)	186.3	155.2
U_l, BTU/(Hr.) (°F) (Lineal Ft.)	30.6	63.0
On the basis equivalent water velocity Water Flow, USGPM	102.0	152.5
Water Velocity, FPS	4.68	4.72
Heat Load, BTU/(Hr.)	411,000	829,000
U_d, BTU/(Hr.) (°F) (Sq. Ft.)	186.3	180.2
U_l, BTU/(Hr.) (°F) (Lineal Ft.)	30.6	73.0
Calculated heat Loads with a fouling factor of 0.0005	390,000	575,000

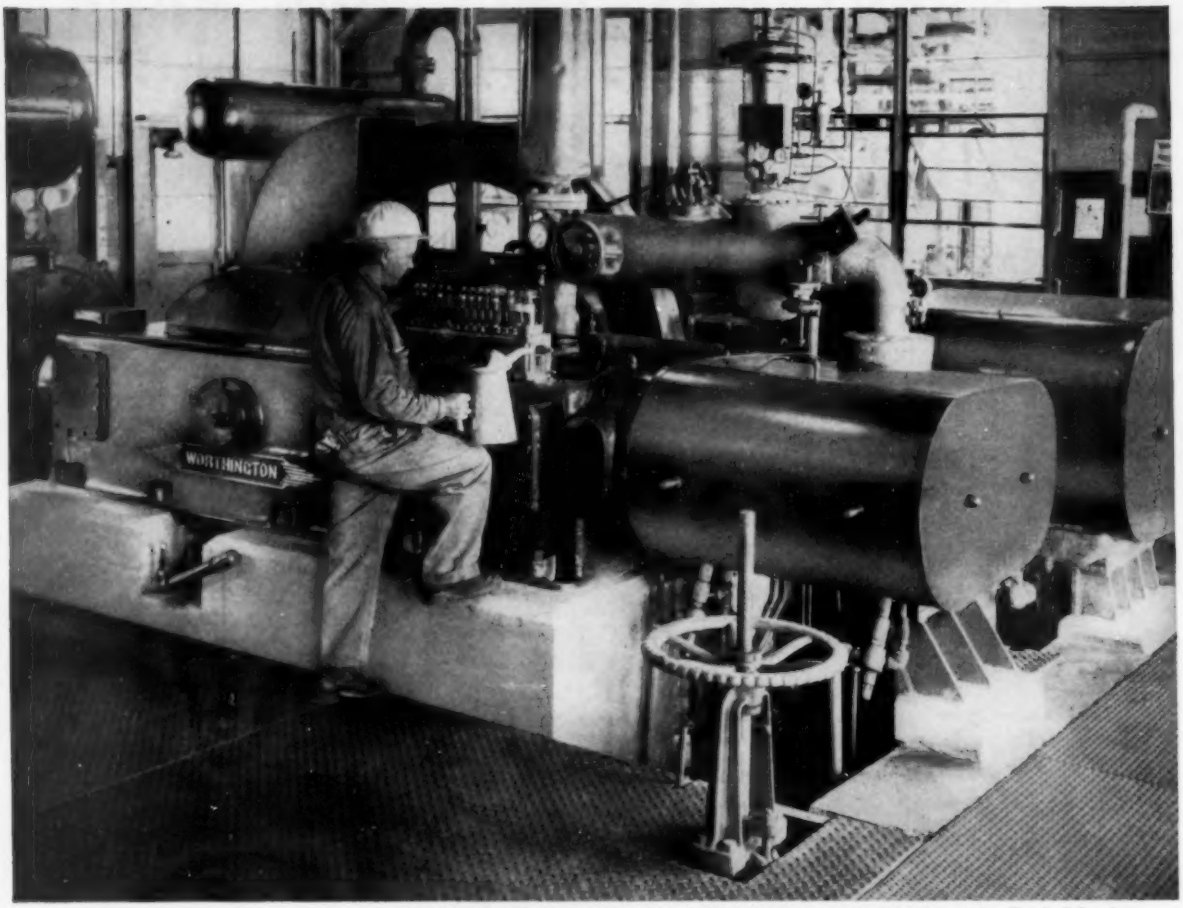
From the data, the advantage of TRUFIN can be clearly seen either on an equivalent water consumption basis or an equivalent water velocity basis.

Although this data was obtained on a clean tube basis, we have shown calculated values on the basis of a fouling factor of 0.0005 (considered to be standard for this service.)

WOLVERINE TUBE, Division of Calumet & Hecla, Inc., 1441 Central Avenue, Detroit 9, Michigan.

WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK



AVAILABLE STEAM DRIVES THIS WORTHINGTON COMPRESSOR at the Rock Island Refining Company in Indianapolis. Part of the hydrocarbon gas being compressed is taken off between compression stages and used to move a catalyst from storage.

Power failure won't stop this compressor

It's a Worthington *steam-driven* compressor which supplements a motor-driven compressor at the Rock Island Refining Company's plant in Indianapolis.

Here's the way Rock Island works it: the motor-driven machine (also a Worthington) is operated as a base load unit. The steam-driven compressor floats on the line, handling any swings in capacity by an increase or decrease in speed. And it's easy to vary the speed — and hence the capacity — by simply turning hand-wheels which control the amount of steam admitted to the compressor. If electrical power fails, the steam-driven unit can take over the entire compression job almost immediately. Result — process keeps going.

Five years of almost continuous operation have shown that the addition of the steam-driven Worthington was a wise move. One of the many features responsible for the fine performance record of this sturdy compressor is the exclusive Worthington Feather* Valve — the lightest, tightest, most efficient valve made. It's standard equipment on every Worthington compressor.

We'd like to help with your compressor problem, too. Write us. Worthington Corporation, Water Cooled Compressor Division, Section K.3.6, Buffalo, N.Y.

**Reg. U.S. Pat. Off.* K.3.6

WORTHINGTON

Only Worthington Compressors Give You Feather Valve Performance

Y-Types • Balanced Angle • Horizontal • Portable • Radial • Gas Engine Compressors

Infrared Analyzer

. . . for continuous process flow control; brochure cites applications, gives specifications and design advantages of the "Tri-Non" stream analyzer. Perkin-Elmer Corp., Norwalk, Conn.

Circle No. **37** *on Reply Card*

Braided Packings

. . . woven so that each strand passes diagonally through the body of the packing, "Lattice Braid"; *Bulletin A-131* contains tables recommending the best types of packing for different service, including asbestos, flax, cotton, Teflon packings. The Garlock Packing Co., Palmyra, N. Y.

Circle No. **38** *on Reply Card*

Meters and Controls

. . . for the process plant; *Bulletin 17-F* contains detailed descriptions and illustrations of equipment, with a table matching different items of equipment with 18 process variables they are designed to measure, transmit, receive, interpret or control. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle No. **39** *on Reply Card*

Aluminum Jacketing

. . . for weatherproofing insulated lines, towers, vessels and tanks; *Folder J-25* contains application instructions, with diagrams showing how to make seals and hems, how to fasten strips and screws, and how to apply jacketing to ells, tees and bends. Childers Manufacturing Co., P. O. Box 7447, Houston 8, Texas.

Circle No. **40** *on Reply Card*

Globe Valve

. . . designed so that area above the piston is twice that under the piston, "Flowtrol" valve; for pressures from 15 to 400 psi.; *Bulletin W8-A* contains construction diagrams, with dimensions and shipping weights, and technical information. Golden-Anderson Valve Specialty Co., 1264 Ridge Ave., Pittsburgh 33, Pa.

Circle No. **41** *on Reply Card*

Multiple-stage Flowmeter

. . . useful with a rate of flow up to 36,000 lbs./hr. when employing five stages; *Bulletin 1052* contains enlargements of the logarithmic scales, sectional view of the flowmeter, and construction advantages. Commercial Research Laboratories, Inc., 20 Bartlett Ave., Detroit 3, Mich.

Circle No. **42** *on Reply Card*

Swivel Pipe Couplings

. . . with ball bearings, in eight different basic types for rotation in one, two and three planes under pressures to 15,000 psi.; *Catalog 234L* describes the low-pressure series of couplings, gives prices and sizes for each style. H. & N. Manufacturing Corp., 3528 Union Pacific Ave., Los Angeles 23, Calif.

Circle No. **43** *on Reply Card*

Closed Circuit Television

. . . for industrial plants; *Bulletin 1175* gives specifications of "UtiliVue" camera, design advantages, and suggested applications. Diamond Power Specialty Corp., Lancaster, Ohio.

Circle No. **44** *on Reply Card*

GLITSCH
BUBBLE CAPS...
ANY SHAPE
ANY SIZE . . .
Existing dies of 287 different cap and riser designs, as well as data on various ratios of related areas, are available to your engineers during planning stages. Practical ideas for improvements to keep apace constantly changing petroleum refining and chemical processing are a GLITSCH service of world-wide proportions.
GLITSCH "TRUSS-TYPE" TRAYS
Lightweight, simple, adaptable with complete freedom of layout, GLITSCH "Truss-Type" mechanical design is not restricted to standardized patterns. You specify your process requirements.
Your engineering staff can effect definite savings in initial designing through GLITSCH world-wide experience in plans, design and fabrication of tower internals.
Cost analyses of tower internal equipment for fabrication in a wide range of material are available promptly.
Glitsch
FRITZ W. GLITSCH & SONS, INC.
P. O. Box 6227
DALLAS 2, TEXAS
SALES OFFICES: New York • Chicago • Cleveland • Houston • Tulsa • Los Angeles

Metering, Proportioning Pump

. . . hydraulic drive, "K" type; *Bulletin KP-54* contains capacity and pressure charts, cross-section diagrams of a pumping unit, photos of several installations. Hills-McCanna, 3025 N. Western Ave., Chicago 18, Ill.

Circle No. **45** *on Reply Card*

Gas Protection Guide

. . . listing the kind of mask needed for 433 hazardous gases, fumes, mists and dusts; limits for determining safe working conditions are described in guide. Acme Protection Equipment Co., 3037 W. Lake St., Chicago 12, Ill.

Circle No. **46** *on Reply Card*

Autofining Desulfurization

. . . process employed by Anglo-Iranian Oil Co., licensed by M. W. Kellogg Co., is described in latest issue of the company magazine; *Kelloggram No. 2* provides details on commercial operation of a 3500 b/d plant where process is used, including data on yields, economics, and a process flow diagram. The M. W. Kellogg Co., 226 Broadway, New York 7.

Circle No. **47** *on Reply Card*

Oil Burners

. . . including a number of types and sizes of both interchangeable and non-interchangeable burners; *Bulletin OB-53* contains illustrations, data, and a section describing the type of air registers used for natural and forced draft, and for oil burning alone or in combination with gas firing. The Engineer Co., 75 West St., New York 6, N. Y.

Circle No. **48** *on Reply Card*

Needle Type Valve

. . . designed for an integrated pneumatic system where precise control of low rates of flow is necessary; *Bulletin 5C-13* has details and a cross-section diagram for each model, a section with formulas and instructions for calculating the size of proper valve for use with liquids, gases and steam, and a table showing nominal needle sizes and corresponding valve coefficients. The Foxboro Co., Foxboro, Mass.

Circle No. **49** *on Reply Card*

Level or Pressure Telemeter

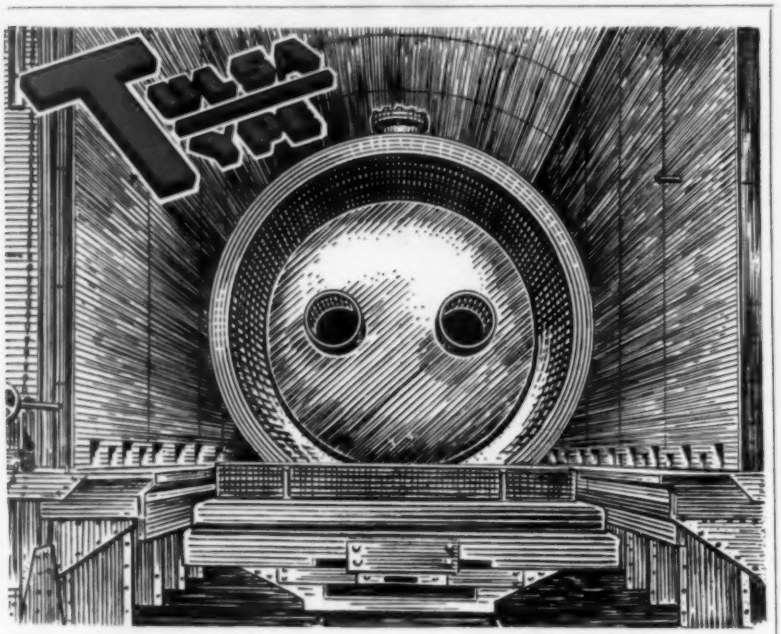
. . . which uses telegraphic signals, the duration of which are proportional to the level or pressure being measured; *Bulletin* 230-*K*10 describes application of this method to level control in reservoirs and tank storage, to pressure control in industrial processes, and to automatic pump control; it contains illustrations of transmitters and receivers and diagrams of installation arrangements. Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle No. **50** *on Reply Card*

Water Treatment

. . . processes, their chemistry and industrial applications; booklet, "If You Use Water," discusses the fundamentals of three main kinds of water treatment based on ion exchange: softening, dealkalization, and deionization; advantages of the more than 12 different processes for specific applications are discussed; flow diagrams included. Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.

Circle No. **51** *on Reply Card*



TURKISH BATH for TIRED TOWERS

Steel plate suffers from stress and strain, even as you and I. So, FLINT STEEL puts completed units through a stress-relieving treatment, in this giant 85-foot long, car-type bake oven. Heated up to a minimum of 1100 degrees Fahrenheit, the molecules in these steel plates "relax", and the stress-free tower which emerges will be stronger — more durable. Just one more example of the careful engineering and processing which go into each piece of TULSA TYPE equipment made only by FLINT STEEL CORPORATION.

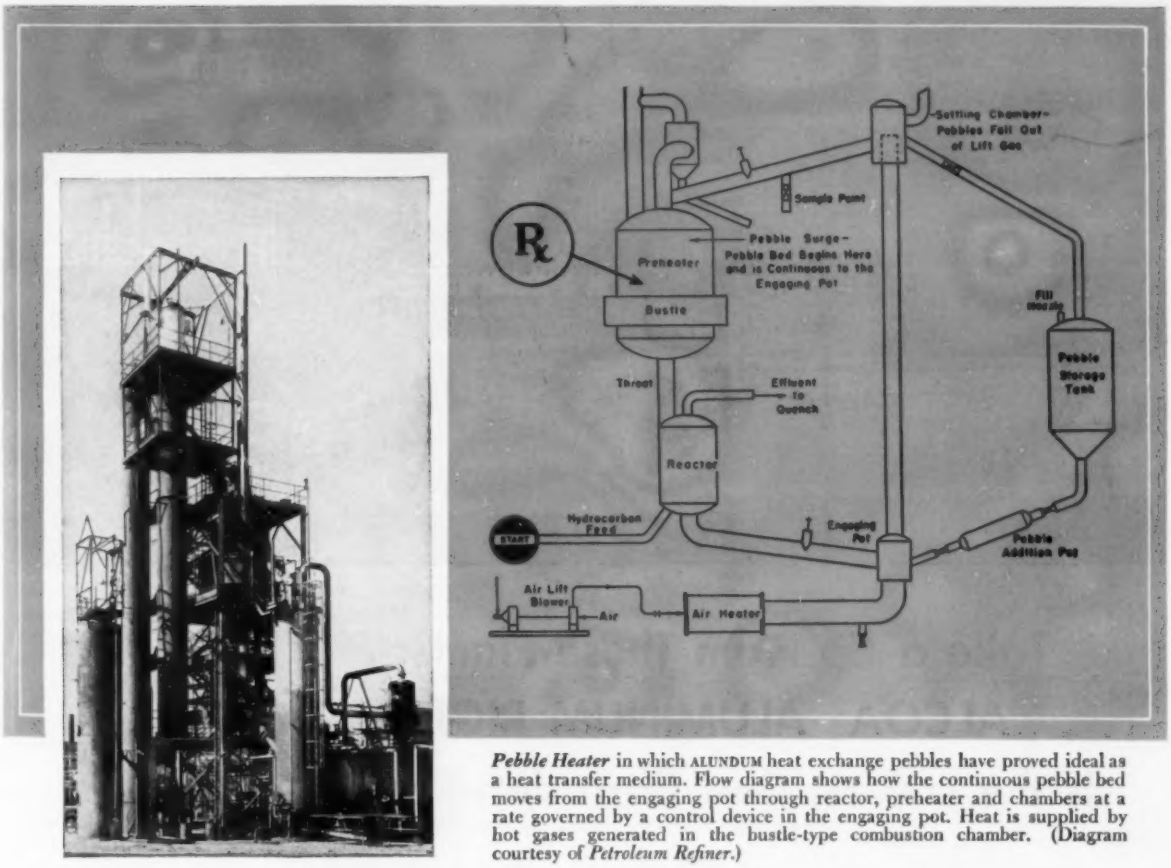
BUILT Right

Write for our General Catalog

FLINT STEEL CORPORATION
TULSA, OKLAHOMA

Rx for cost-saving efficiency

in high temperature processing...



Pebble Heater in which ALUNDUM heat exchange pebbles have proved ideal as a heat transfer medium. Flow diagram shows how the continuous pebble bed moves from the engaging pot through reactor, preheater and chambers at a rate governed by a control device in the engaging pot. Heat is supplied by hot gases generated in the bustle-type combustion chamber. (Diagram courtesy of *Petroleum Refiner.*)

Pebble heaters with ALUNDUM* pebbles

Pebble heaters are now available which are capable of heating gases above operating temperatures permissible in conventional tube furnaces. Low initial cost, high operating efficiency and the use of low cost gas or oil fuel are attracting favorable attention to these heaters for high temperature processing.

For the production of ethylene, for example, the Phillips Petroleum Company has installed a 30 Mm Btu per hour commercial pebble heater at Borger, Texas, following several years of successful pilot plant operation.

In this installation, Norton ALUNDUM heat exchange pebbles have given excellent results. ALUNDUM pebbles, *engineered* to stand up under abrasion, impact and repeated heating and cooling, are *prescribed* as the ideal heat transfer medium for pebble heaters. Also, their high refractoriness, which prevents softening or incipient fusion at any point in the pebble heater's upper bed, keeps them from "bridging" together and causing stoppages in the moving bed.

Rx's for YOUR refractory needs

are included in the broad Norton line of *engineered and prescribed* refractories. For information concerning ALUNDUM heat exchange pebbles or other Norton refractories, or for expert technical aid, call in your Norton Refractories Engineer. Or write to NORTON COMPANY, Refractories Division, 268 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Canada.

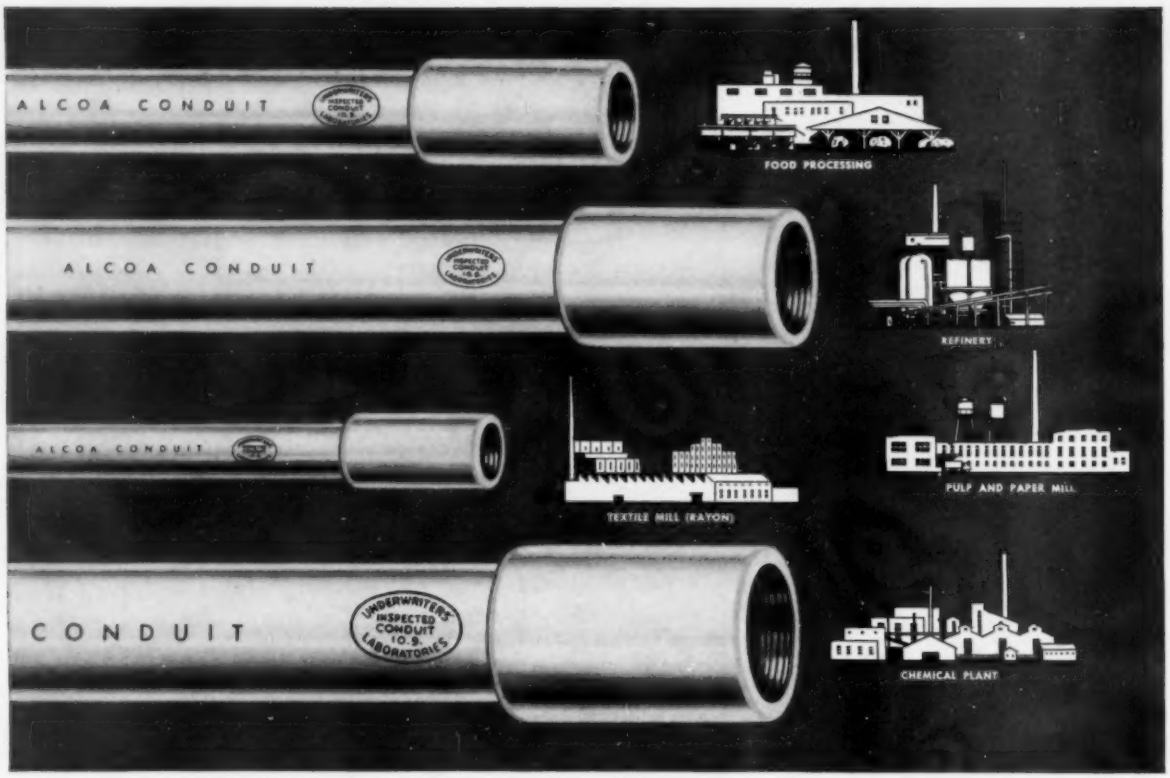
NORTON

REFRACTORIES

Engineered... Rx... Prescribed

Making better products... to make other products better

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries



Take a Tip From These Plants:
ALCOA® ALUMINUM RIGID CONDUIT
Is the Lowest Cost Corrosion-Resistant Conduit

Alcoa Aluminum Rigid Conduit, especially resistant to industrial atmospheres that often attack other metals, costs less than any other corrosion-resistant conduit. The excellent performance of aluminum conduit in corrosive conditions means lower maintenance costs and less frequent replacement.

In addition, Alcoa Aluminum Rigid Conduit is nonmagnetic, lowers voltage drop, eliminates overcrowding of terminal enclosures and simplifies the installation of electrical equipment having widely spaced terminals.

Alcoa Aluminum Rigid Conduit reduces handling, fabricating and installation costs. It is only about one-third the weight of the same size in steel. A 10′ length of the 4″ size weighs only 33 pounds and can easily be handled by one man.

Alcoa Aluminum Rigid Conduit is approved by Underwriters' Laboratories, Inc. and each piece bears their label. It is readily available. Call your local Alcoa sales office, listed under "Aluminum" in your classified directory. ALUMINUM COMPANY OF AMERICA, 2093-J Alcoa Building, Pittsburgh 19, Pa.

For complete information write for Alcoa's new booklet, *Alcoa Aluminum Electrical Rigid Conduit.*

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Liquid-level Gage

. . . with a non-magnetic float enclosing a magnet that varies the gage indicator, which is completely separate, by magnetic force alone; *Bulletin 501* describes and diagrams operation, lists design features. Liquidvision Gauge & Control Corp., P. O. Box 51, Oceanside, L. I., N. Y.

Circle No. **52** *on Reply Card*

Valveless Pumps

. . . used with flexible tubing, for liquids, slurries or gases, "Sigmamotor"; bulletin is illustrated with pictures of models suitable for various applications, contains full operating information, data about proper tubing for each model. Sigmamotor, Inc., 3 N. Main St., Middleport, N. Y.

Circle No. **53** *on Reply Card*

Gas Monitoring System

. . . which continuously measures oxygen in a natural gas collection system, preventing explosions due to the compression of air-gas mixtures; *Bulletin AD-612* contains schematic diagram of sampling system, description of equipment needed. Arnold O. Beckman, 1020 Mission St., South Pasadena, Calif.

Circle No. **54** *on Reply Card*

Valve Comparison Chart

. . . listing valve figure numbers of 15 major manufacturers and the company's equivalents; chart in booklet form compares gate, check, globe, and angle valves in bronze, iron, cast steel and forged steel; lubricated plug valve comparisons include those made of cast steel and cast iron. Ohio Injector Co., Wadsworth, Ohio.

Circle No. **55** *on Reply Card*

New Lab Equipment

. . . is described in 20th edition of "What's New for the Laboratory"; included are a new balance, colorimeter, explosion-proof mixer, magnetic stirrer, recording spectrophotometer, etc.; items are illustrated and specifications and prices are given. Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Circle No. **56** *on Reply Card*

Low Voltage Switchgear

. . . air circuit breaker of the drawout and stationary types and the stationary type of molded case circuit breaker; *Bulletin* 200 pictures and describes complete units and their components; gives specifications and layout information. Continental Electric Equipment Co., Cincinnati, Ohio.

Circle No. **57** *on Reply Card*

Automatic Chlorine Proportioner

. . . for use with company's chlorinator; *Catalog 70-20* has cross-section diagram of proportioner, diagram of installation, schematic flow diagram of chlorinator with proportioner, and specifications. Fischer & Porter Co., Hatboro, Pa.

Circle No. **58** *on Reply Card*

Thermocouple Wire

. . . and thermocouple extension wire are listed in *Form 1200;* bulletin gives sizes, metals, insulations and prices, also general application data. Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

Circle No. **59** *on Reply Card*

Leaders in refining, processing and manufacturing industries have selected Lincoln Explosion-Proof Floor Maintenance Machines. This proves Lincoln machines operate with absolute safety and effect substantial floor maintenance savings. A free demonstration will prove you can save up to 75% on your floor maintenance costs. Mail coupon today.

All electrical parts sealed for explosion-proof operation and carry Underwriter's Laboratories approval.

REPRESENTATIVE USERS *include*

• E. I. DuPont de Nemours Co. • Douglas Aircraft Co.
• General Mills, Inc. • Shell Pipe Line Co. • The Upjohn Co.

LINCOLN-SCHLUETER FLOOR MACH. CO. 1251 West Van Buren Street, Chicago 7, Illinois
Without obligation, please send complete information on:
( ) Lincoln EXPLOSION-PROOF AUTO-SCRUBBER
( ) Lincoln EXPLOSION-PROOF Single-Disc SCRUBBER and POLISHER
( ) And arrange for a FREE DEMONSTRATION
Name_____
Firm_____
Address_____
City_____ Zone____ State_____

Lincoln-Schlueter
FLOOR MACHINERY COMPANY
1251 WEST VAN BUREN ST., CHICAGO 7, ILLINOIS
MORE THAN 50 YEARS OF SERVICE
WORLD'S MANUFACTURER OF THE MOST COMPLETE LINE OF FLOOR MAINTENANCE EQUIPMENT

HERE'S THE *New* RUPTURE DISC FOR BS&B SAFETY HEADS...

...ESPECIALLY DESIGNED FOR USE IN LOW PRESSURE APPLICATIONS UNDER SEVERE CORROSIVE CONDITIONS!

For many years the problem of producing a low pressure rupture disc that could withstand prolonged exposure to severe corrosive conditions was a perplexing one. Yet, it was a problem that *had* to be solved, particularly for the Process Industries.

Therefore, it was only natural that BS&B — originator of the Safety Head — should come up with the right answer in the form of a flat type rupture disc whose bursting pressure is controlled by a top metal section, isolated from the corrosive contents of the protected vessel by a sealing membrane of Teflon or Kel-F.

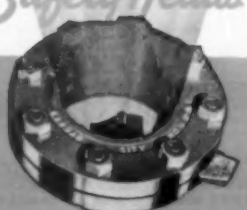
If back pressure is not anticipated, the bottom metal section of the disc is cut open to full relieving capacity (Model 1A). However, if a vacuum support is needed, the bottom metal section is constructed similar to the top section to serve as a vacuum support (Model 1B). Top and bottom sections are spot welded together to give a single compact unit.

Disc Models 1A and 1B are constructed of corrosion-resistant metals such as Inconel, stainless steel, nickel, Hastelloy B and Monel. Either model is available in 2", 3", 4", 6", 8" and 10" sizes. Pressure ratings are from 8 to 100 lbs. Close design tolerances are an inherent feature of this type disc.

If you have a pressure relief problem which you have not been able to solve satisfactorily with the regular pre-bulged type of disc or other types of relief devices, try the new BS&B Model 1A or 1B disc. It fits any standard size BS&B Safety Head flanges you may now have in service. Also available in a complete assembly consisting of inlet and outlet flanges, rupture disc, studs and nuts.

Your BS&B Man will be glad to give you details . . or you may write for descriptive literature and prices.

BS&B Safety Heads



THE "CIRCUIT-BREAKER" OF Pressured Systems

EFFICIENCY OVER 60 YEARS BS&B RELIABILITY

BLACK, SIVALLS & BRYSON, INC.
Safety Head Division, Dept. 2-D9
7500 East 12th Street, Kansas City 26, Mo.

What's New!

Octyl and Nonyl Phenol

. . . their structure, uses, properties and chemical reactions; bulletin *SP-98* diagrams and describes 14 reactions. Rohm & Haas Co., Washington Sq., Philadelphia 5, Pa.

Circle No. **60** *on Reply Card*

Did You Miss These?

The following items, reviewed originally in July, have aroused considerable interest among the readers. They are repeated briefly as a service to those who might have missed them the first time they appeared. For details or literature, please use the regular Reply Card in this issue.

Graphite Material Withstands Temperatures Up to 5700° F.

. . . and almost all types of corrosives. Trademarked under the name "Graph-I-Tite," it is an impervious graphite and is being used in such processing equipment as heat exchangers, boots, nozzles, and the like. Its ability to hold up under high temperatures is said to be due to the fact that carbon itself is used to fill the pores in the graphite, rather than the usual resins, which would be subject to chemical attack or decomposition from heat. In tests, the material has given good service at the boiling temperatures of all concentrations of such corrosives as formic, hydrochloric, monochloracetic, and oxalic acids; ammonium hydroxide, ferric chloride, nickel sulfate, acetone, benzene, carbon tetrachloride, ethylene dichloride, gasoline, isopropyl alcohol, and trichlorethylene. Two grades are currently being made available. Grade "A" has maximum impermeability and a temperature limit of 1300° F.: Grade "G" has a limit of 5700° F. but is slightly permeable to nitrogen at 40 psi., though impermeable at that pressure to liquids with viscosities greater than that of water. Falls Industries, Inc., Solon, Ohio.

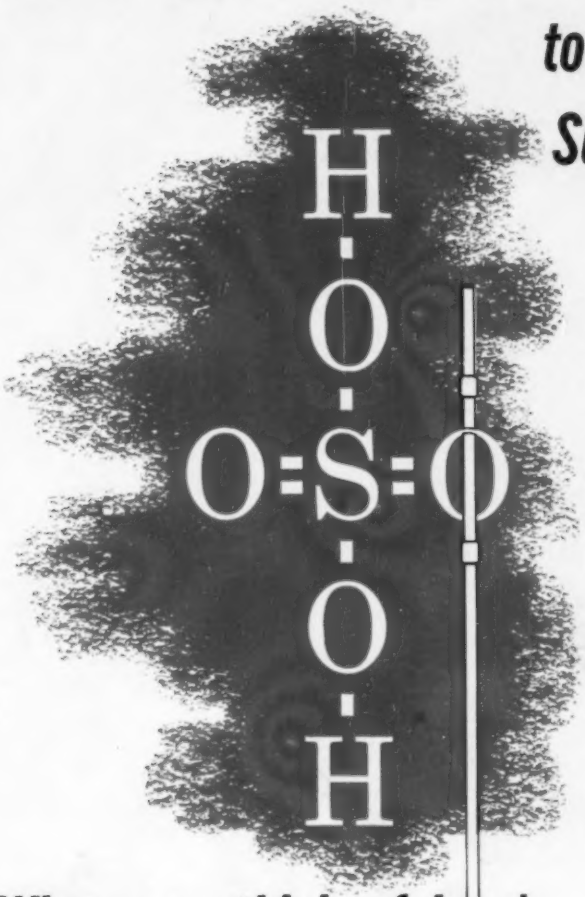
Circle No. **61** *on Reply Card*

Graphitization Study

. . . made over a 10-year period: reprinted in a 12-page booklet; subject is discussed from standpoint of temperature, chemical composition, deoxidation practice, stress and strain; includes photos and drawings illustrating the structural formations of steel. Edward Valves, 1201 West 145th St., East Chicago, Ind.

Circle No. **62** *on Reply Card*

When *is Lead used to control Sulphuric Acid Corrosion?*



Sulphuric acid is like "Peck's Bad Boy."

It has plenty of outstanding qualities, but it's hard to control.

Ordinarily, lead is the metal used by industry to keep sulphuric acid corrosion within limits. Lead is often used when H_2SO_4 concentrations go as high as 96% at room temperature or as high as 85% at 220 degrees Centigrade.

When making equipment to handle H_2SO_4 within such ranges, lead will usually give you the most practical combination of corrosion resistance, simple fabrication, and reasonable cost. No common metal is easier to work than lead and it is economical, both in first cost and in maintenance.

With other corrosives the detail differs but the story is much the same. So when you think of corrosion resistance, think of lead and . . .

When you think of Lead . . . think of National Lead

WHAT GOES FOR LEAD AND H_2SO_4 GOES FOR LEAD AND HUNDREDS OF OTHER CORROSIVES

National Lead puts lead in your hands in any grade you may require and in every conceivable form — sheet, pipe, coils, fittings, valves, pumps and vessels. Or you can have National Lead fabricate lead equipment to your specifications.

So put National Lead first in your thinking when you want to combat corrosion. Call on National Lead for technical assistance. Ask for a copy of the new booklet on "Chemical Lead Products."

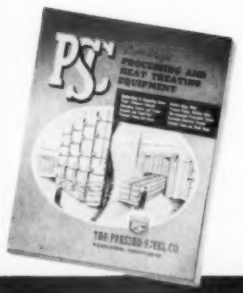
National Lead Company

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Limited).

*Reg. U. S. Pat. Off.

 (To obtain more data on advertised products see page 1464)

As a leading supplier of bubble caps, PSC not only offers a wealth of production know-how but also substantial economies. With dies on hand for 300 standard styles, PSC is saving many customers the cost of dies, as well as design and delivery time. Special caps to order. Some customers have effected maintenance economies with PSC units because we fabricate from any metal which will best meet their specific requirements: aluminum, brass, copper, nickel, carbon steel, any chrome or chrome-nickel stainless. For engineering data on the 300 standard styles SEND FOR CATALOG 54.



THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

New Catalyst Is Developed for H_2S Removal from Air or Gas

. . . streams. The basis of the catalyst is activated carbon treated with various metal oxides such as vanadium, copper, iron and/or chromium. Hydrogen sulfide is oxidized to sulfur and water with 100% efficiency from gases or air in a wide range, up to 2% by volume, until the activated carbon has increased in weight by 25%. This increase is 10% water and 15% sulfur. Breakdown of the catalyst is reached when it passes 5 ppm. of the H_2S. Reactivation may be accomplished by steaming or dissolving the sulfur, then drying the catalyst with a current of air heated to about 125° C. Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J.

Circle No. **63** *on Reply Card*

Synthetic Ammonia

. . . produced by combining the Texaco Development Co.'s partial oxidation process and the Casale synthetic ammonia process in an especially designed sequence: *Bulletin No. 0-54-1* contains process flow diagram, step-by-step explanations of each of the processes, and a tabulation of raw materials needed. Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.

Circle No. **64** *on Reply Card*

Stainless Steel Performance

. . . in petroleum refinery service; a 46-page booklet with complete data on corrosion resistance and high temperature properties in tables and charts; application information with drawings indicating where these alloys are used in six different petroleum processes. United States Steel Corp., Pittsburgh 30, Penna.

Circle No. **65** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of Petroleum Processing to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item. Then fill in the rest of the card and drop it in the mail. No postage is required.

This is no accident!

Here's perfection . . . down to the last morsel! No slap-dash guesswork here. Into this masterpiece have gone the finest of ingredients, precisely blended with the special skill of the master-baker.

In the same sense, Plibrico specialists blend superior refractory materials . . . for *your* needs.

But as with fine pastry, dough alone doesn't finish the job! So Plibrico engineers work with you from the grassroots level, blueprinting plans best suited to your problems. Finally, expert crews complete construction efficiently and economically. For superior service, call for *Plibrico* . . . where you *know* you're getting your money's worth!

Plibrico Company

1824 North Kingsbury Street, Chicago 14, Illinois

PLIBRICO SALES & SERVICE IN PRINCIPAL CITIES

which impulse for you?

STANDARD

The standard YARWAY Impulse Steam Trap serves all normal trapping requirements. Factory set to operate without adjustment at all pressures from 20 psi to 400 psi (Series 60) and 600 psi (Series 120). For pressures below 20 psi, merely remove split washer.

Numerous advantages like:

small size
quick heating
steady temperatures
stainless steel construction
one moving part
non-freezing
low cost

More than 900,000 used throughout industry.

Write for YARWAY Bulletin T-1740.

HIGH PRESSURE, INTEGRAL STRAINER

YARWAY Integral Strainer High Pressure Impulse Steam Traps operate on some of the highest pressure steam lines in the country. Same operating principle as the standard YARWAY Impulse Trap. Strainer built into trap.

Ample capacity when system is being "warmed up"—yet will handle relatively small amounts of high temperature condensate without losing prime. Six sizes—½" to 2". Pressures to 1500 psi (flanged ends) or 2500 psi (welding ends).

Write for YARWAY Bulletin T-1740.

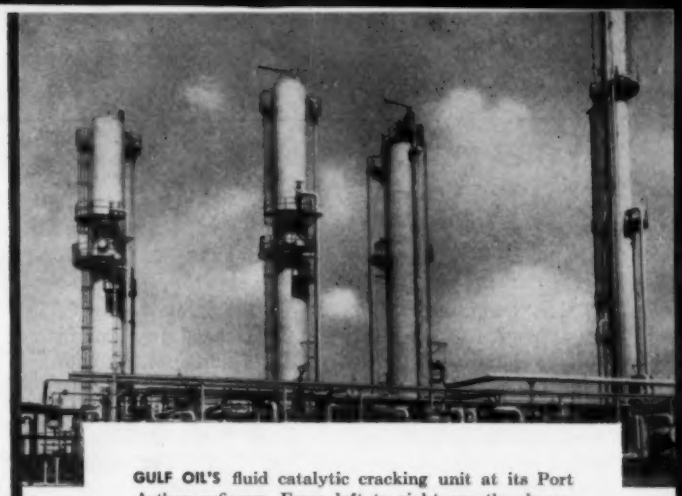
YARNALL-WARING COMPANY
153 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY

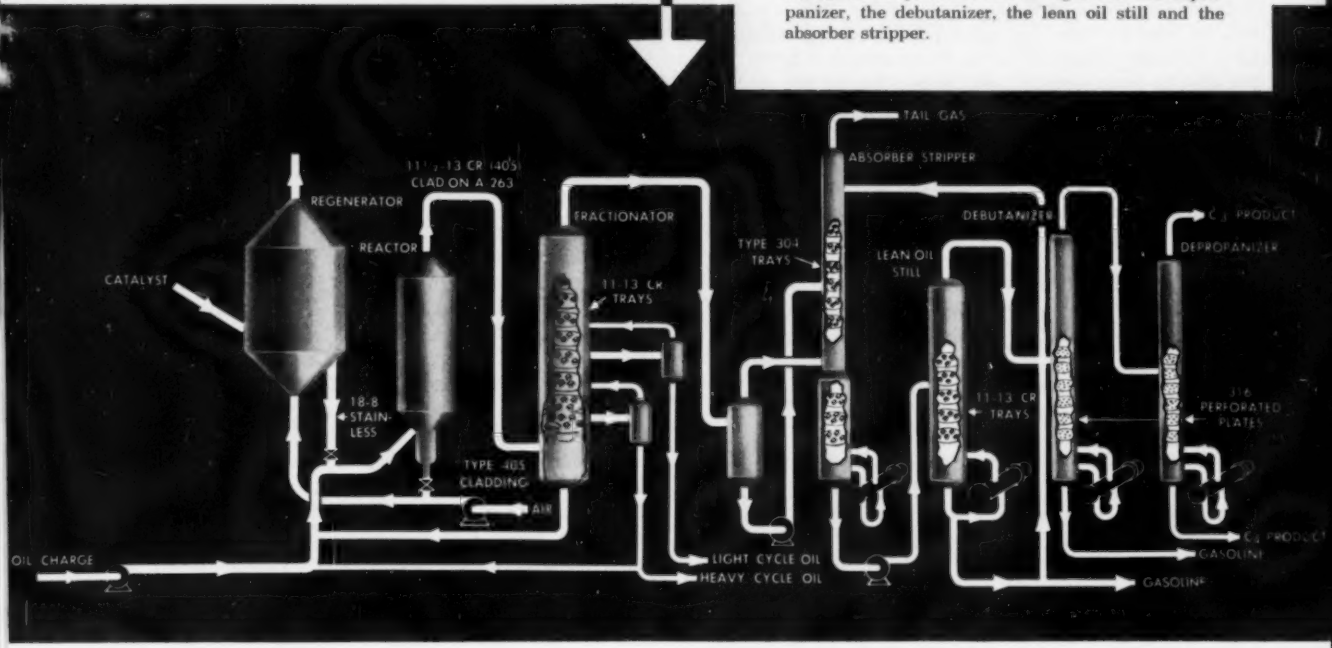
impulse steam traps

YARWAY Impulse Steam Traps and Fine Screen Strainers are stocked and sold by more than 250 convenient local distributors. Write for name of one nearest you.

HOW GULF USES STAINLESS STEEL in a fluid catalytic cracking unit



GULF OIL'S fluid catalytic cracking unit at its Port Arthur refinery. From left to right are the depropanizer, the debutanizer, the lean oil still and the absorber stripper.



THE fluid catalytic cracking unit diagrammed here was built in 1951 for the Gulf Oil Corporation's Port Arthur, Tex., refinery. With the help of Stainless Steel—used extensively in trays and piping—this unit handles 65,000 barrels of prepared charging stock daily.

The flow chart shows the various grades of Stainless used in different parts of the unit. Trays in the absorber stripper are Type 304 Stainless Steel, while tray plates in the debutanizer and in the depropanizer are Type 316.

Such careful selection of grades is extremely important in obtaining the maximum corrosion resistance and long life from Stainless Steel. Properly applied, Stainless Steel is one of the most important tools you can use in keeping your refinery operations on stream at all times.

Our new book, "Performance of Stainless Steels in Petroleum Refinery Service," contains much valuable data on properties of various grades. If you do not have a copy, mail the coupon below. And our representatives are always available to assist you in the selection of the right grade of perfected, service-tested USS Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · USS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

4-883

United States Steel Corporation
525 William Penn Place, Room 4468
Pittsburgh 30, Pa.

Please send me my copy of "Performance of Stainless Steel in Petroleum Refinery Service."

Name .....

Title .....

Company .....

Address .....

City ..... State .....

EDITORIALS . . .

Thinking of Petrochemicals?

THE continuing expansion of the manufacture of chemicals from petroleum and natural gas, both in volume and in number of products made, will create opportunities for new companies to enter this business. For the oil concerns, not as familiar with this type of operation as the chemical companies, there are hazards which must first be correctly appraised if the venture into petrochemicals is to be fully profitable.

First, the investment in processing facilities required will be found many times that for petroleum refining. One authority gives $12,500 as an average figure for the capital necessary to process one barrel per day of charge stock into a petrochemical. The amount will vary with the end product made and will pyramid with successive processing steps. This compares with an investment of around $1000 per barrel per day for a light oils refinery. Another authority states the investment required to convert liquefied petroleum gas into polyethylene is in the neighborhood of $70,000 per barrel per day of product. This figure includes the manufacture of ethylene from LPG, its purification and polymerization to crude polyethylene. The investment to recover the LPG in the refinery or natural gasoline plant is $1000 to $1500 per barrel per day of LPG recovered.

Product realization is in somewhat the same ratio as the differences in capital investment for straight petroleum refining and for petrochemical manufacturing. The refiner figures in cents per gallon, the chemical manufacturing company in cents per pound.

Again, the prices for his products the petroleum refiner can anticipate receiving after his plant is built are more stable than those for petrochemicals. The downward price trends of the past year or so for synthetic alcohol, benzene, toluene, methanol and polyethylene, to mention only a few products, put a different light on the degree of profitability of a plant built now, which must pay out at current prices, as compared with conditions a few years ago.

The marketing practices followed in selling petrochemicals will be new and different to the processor of straight petroleum products. Chemicals are sold in uniform delivered prices, and published prices often do not reflect the true markets. When supplying the tank car trade in petrochemicals, the producer will have to own and operate his own tank cars, not lease them from a central agency as most refiners do. The cars often have to be of special construction, with special precautions taken in their loading and unloading.

Research is a necessary requirement and investment for the individual company getting into the manufacture and marketing of petrochemicals. That this is new for a great many oil companies is borne out by the fact that the petroleum industry spends today 0.6¢ of dollar sales for all research, while the chemical industry spends 3-4¢, a good share of it in finding and developing new markets for its products. The individual chemical company looks upon market research as coming first and as even more necessary than a sales staff to find and maintain volume for the output of its plants.

The oil company, familiar for the most part with having its products' markets determined by the equipment using them as fuels and lubricants, will find other new problems to be solved in entering the petrochemical field. The company that weighs and evaluates them correctly as the first step in any proposed expansion of its activities in this direction will have the best chance of making the venture profitable.

Act of Congress—the Last Stand?

THE petroleum industry is now a step closer to federal regulation through the recent decision of the U.S. Supreme Court upholding the authority of the Federal Power Commission to fix prices at the well for natural gas moving in interstate commerce, even those of a company with strictly intrastate gas producing operations. The Court was divided on the issue. A dissenting minority of three justices recognized the "liberal" interpretation of the majority of five who handed down the ruling, by stating the ruling "brings every gas operator, from the smallest producer to the largest pipeline under federal regulatory control."

The Supreme Court did not specifically hold that the FPC was granted by Congress the right to decide matters of oil and gas production, and how natural gas extraction, cycling, natural gasoline plants and refineries shall be operated, since they are allied in their handling of liquids taken from natural gas.

However, it is well established that the power to fix prices carries with it the authority to supervise and regulate operations as necessary to determine "reasonable" prices. In times past the power agency has publicly made its own interpretation of its powers under the Natural Gas Act as broad enough to include gas processing and oil producing when occurring with the production of natural gas. There is nothing in the Supreme Court's decision which would limit the authority the FPC may take unto itself to "protect consumers against exploitation at the hands of the natural gas companies," to use words from the Supreme Court ruling.

It is unfortunate that the oil and gas industries failed to work for an act of Congress defining the authority of the Federal Power Commission under the Natural Gas Act when Truman vetoed the Kerr bill in the latter part of his administration. It was perhaps thought wishfully that the philosophy of greater recognition of states' rights held by the new Administration would be reflected in the thinking of the Supreme Court.

Spelled-out legislation by Congress in the form of an amendment to the Natural Gas Act is the only way now left to make certain once and for all that the authority of the Federal Power Commission is actually limited to what Congress undoubtedly had in mind when it passed the gas act. It is too late for such legislation to be introduced in this session of Congress, but it is not too early for the oil and gas companies to acquaint their Congressmen with the issues at stake and to make sure that the definitive legislation is introduced at the earliest possible date.

BENEFITS You can get with SULFAN® (Stabilized Sulfuric Anhydride) for Sulfonated Lube Oil Additives

and other

Emulsifying and Demulsifying Agents

BENEFIT No. 1 **Increase Yields**

Because of the extremely reactive nature of SULFAN, higher molecular weight compounds can be sulfonated to produce desirable oil soluble sulfonates. Treatment with Sulfuric Acid or 20% Oleum leaves these compounds unreacted.

BENEFIT No. 2 **Eliminate Waste Acid Problem**

Since water is not formed when SULFAN is used for sulfonation, the waste acid problem inherent in using Sulfuric Acid or Oleum is eliminated.

BENEFIT No. 3 **Improve Sulfonation Efficiency**

SULFAN has 99.5% SO_3 available for sulfonation reactions; thus, for many applications SULFAN offers nine times as much usable SO_3 as 100% Sulfuric Acid and over three times as much as 20% Oleum. This can mean a considerable saving in sulfonation costs.

BENEFIT No. 4 **Step Up Processing Efficiency**

The absence of waste acid when using SULFAN permits larger batch sizes or more rapid through-put in a sulfonation process. This means that by using SULFAN, batch size or through-put can be doubled or tripled without increasing the size of the equipment.

Tank Car Quantities

A laboratory development just a few short years ago, SULFAN today is a commercial chemical of ever-growing importance. This new processing tool is now being regularly shipped to many users in tank car quantities. For technical data on SULFAN, experimental quantities, or other assistance, contact any General Chemical office listed below.

Basic Chemicals For American Industry

Allied Chemical

GENERAL CHEMICAL DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte Chicago • Cleveland • Denver • Detroit • Greenville (Miss.) • Houston • Jacksonville • Kalamazoo Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Providence • San Francisco Seattle • St. Louis • Yakima (Wash.) • In Wisconsin: General Chemical Company, Inc., Milwaukee

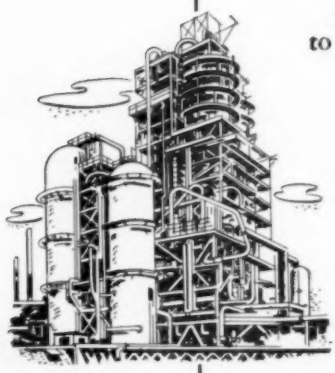
In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

STABILITY

It is Wyatt's policy to maintain financial structure to match its plant structure. This surplus item in the assets column is in reality just another working tool.

As processing equipment becomes larger and more intricate, Wyatt's plants must be enlarged and fitted to meet their obligation. That is when a surplus ceases to be cash on hand and goes to work itself.

Putting some of the profit back in the business also gives a lift to employment, since men go to work as dollars go to work.



Wyatt's

HOUSTON-DALLAS-NEW YORK-TULSA

MANUFACTURERS AND ERECTORS SINCE 1913